Virtual Coaching Activities for Rehabilitation in Elderly

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Lead author(s):	Lars Böcking (FZI)
Coauthor(s):	Patrick Philipp (FZI), Kropf Johannes (AIT), Sandner Emanuel (AIT), Mircea Vasile (SIV), Alvaro Martines (MYS), Kai Gand (TUD), Hannes Schlieter (TUD), Carola Gisske (TUD), Lorenzo Mureddu (IMA), Vito Nitti (IMA), Massimo Caprino (CCP), Irma Sterpi (CCP), Enrica Tricomi (CCP), Rocio Del Pino (OSA), Riccardo Re (CCP), Juan Carlos Gómez Esteban (OSA/BCB), Stefan Busnatu (UMFCD), Victor Cojocaru (UMFCD)
Reviewers:	Kropf Johannes (AIT), Rocio Del Pino (OSA), Kai Gand (TUD), Enrica Tricomi (CCP), Luc Nicolas (EHTEL)

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Document history

Table 1: Document history

Version	Date	Author/Editor	Description
0.1	27.05.2020	Lars Böcking	Initial document
0.2	29.05.2020	Lars Böcking	ToC & evaluation template
0.3	30.06.2020	Lars Böcking	Test documentation FZI requirements
0.4	08.07.2020	Lars Böcking	FZI Sequence diagrams
0.5	09.07.2020	Patrick Philipp	Update on Planned Tech Lab activities, Tech Lab Germany, Executive Summary, Conclusion, Next Steps
1.0	13.07.2020	Johannes Kropf, Mircea Vasile	AIT & SIV use case test documentation
1.1	13.07.2020	Lars Böcking	Version internal review
1.2	17.07.2020	Lars Böcking	Minor adjustments
1.3	21.07.2020	Lars Böcking	Final review
2.0	01.12.2020	Massimo Caprino	Revision, added participatory design chapter
2.1	10.12.2020	Lars Böcking	Final version 2.0

EXECUTIVE SUMMARY

This document, Deliverable 1.6, documents the realisation of Tech Labs conducted in Germany, Spain and Austria and follows the respective study design presented in D1.5. It documents the technical setup of the vCare solution's components building the basis for upcoming tests phases (see Figure 1 for an overview). The core of D1.6 is the test report for the respective Stroke-, Parkinson's disease-, heart failure- and Ischemic heart disease-related activities for which, based on the study design, a common evaluation is established. The latter comprises a detailed description of the test setup including the test preconditions, the test conducted execution, the test validation dimensions, the comments and impressions of medical partners during and after the tests, and finally a comprehensive test summary. In addition to the functional requirements validated by the test cases, the non-functional requirements are also addressed. Furthermore, D1.6 provides a general elaboration on the integration progress of the technical vCare components, where the used methods and tools and outcomes are focussed on.

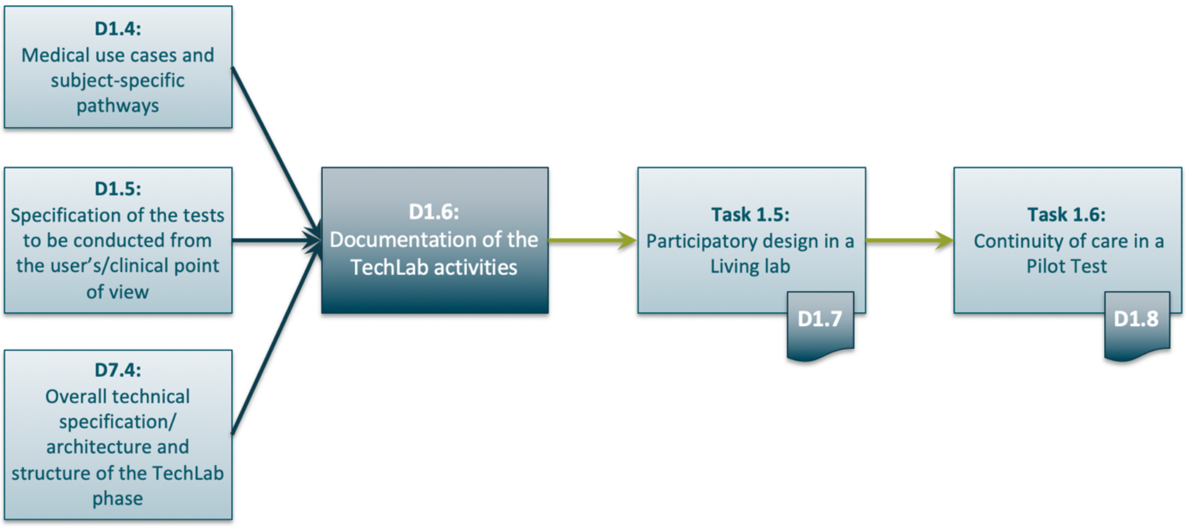

Figure 1: Relations of deliverable D1.6

D1.6 reports that the Tech Labs, while restricted by the Corona virus epidemic, significantly advanced the technical integration as well as the integration of medical domain knowledge into technical components of vCare. As thoroughly explained in this deliverable, the resulting adapted goal of D1.6 was to conduct semi-integrated tests of the technical components, enabling to partially simulate system interaction when a full system setup was not possible due to travel restrictions. However, all technical interfaces were fully defined and implemented, such that data- and information flow is possible throughout the vCare system.

In parallel to the validation of the technical components and the evaluation of the defined interfaces within the vCare architecture, the focus was on information processing. While the test implementation concentrated on the exchange of simulated data via the defined interfaces, the regular discussions with the medical partners allowed additional knowledge about the processing of more extensive data from a medical perspective and the interaction with patients to be integrated.

As shown by the conducted test documentation (see Table 2 for a first overview; details are presented in sections 6 and 7), the stipulated requirements of the disease-related activities were fulfilled, enabling to proceed to the Living Labs, where the medical personnel will continue to test the vCare system and resulting required technical adaptations will be discovered and implemented.

Table 2: Test results overview

Requirement Reference[1]	Testcases ID[2]	Status
R2-1: Home's room detection	A-6 SD – DS1	**Passed**
	A-2 PD – DS1	Same as A-6 SD – DS1
	A-12 HF – DS1	Same as A-6 SD – DS1
R2-3: Body position detection	A-1 SD – DS2	**Passed**
	A-1 PD – DS2	Same as A-1 SD – DS2
	A-14 HF – DS2	Same as A-1 SD – DS2
	A-14 IHD – DS2	Same as A-1 SD – DS2
R2-5: Fall detection	A-11 PD – DS4	adjusted
R2-6: Activity Monitoring	A-2 SD – DS1	**Passed**
	A-2 PD - DS1	**Passed**
	A-20 IHD – DS1	Same as A-2 SD – DS1
R2-7: Home inactivity detection	A-1 SD – CS6	**Passed**
	A-2 SD – DS1	**Passed**
	A-1 PD – CS6	Same as A-1 SD – CS6
	A-2 PD – DS1	Same as A-2 SD – DS1
	A-5 PD – CS6	Same as A-2 PD – CS6
	A-15 PD – CS6	**Passed**
	A-12 HF – CS6	Same as A-1 SD – CS6
	A-12 HF – DS1	Same as A-1 SD – DS1
	A-14 HF – CS6	Same as A-2 SD – DS1
	A-15 HF – CS6	Same as A-15 PD – CS6
	A-14 IHD – CS6	Same as A-2 SD - DS1
	A-2 SD – DS7	**Passed**

[1] The technical requirements are defined in D7.4.
[2] The test cases are defined in D1.5. SD=Stroke Disease, PD=Parkinson's Disease, HF= Heart Failure, IHD=Ischemic Heart Disease

R2-8: Home Behaviour Monitoring	A-2 PD – CS6	Same as A-2 PD – DS7
	A-5 PD – CS6	Same as A-3 SD – DS7
	A-15 PD – CS6	**Passed**
	A-3 HF – DS7	**Passed**
	A-12 HF – CS6	Same as A-3 SD – CS6
	A-15 HF – CS6	Same as A-15 PD – CS6
R2-9: Deviating behaviour detection	A-3 SD – DS7	**Passed**
	A-2 PD – DS7	**Passed**
	A-3 PD – DS7	Same as A-3 SD – DS7
	A-3 HF – DS7	**Passed**
	A-3 IHD – DS7	Same as A-2 PD – DS7
R2-10: Emotion recognition	A-19 HF – DS9	Partially passed
	A-19 HF – DS8	adjusted
	A-19 IHD – DS8	Same as A-8 HF – DS8
	A-19 IHD – DS9	Same as A-8 HF – DS9
R3-1: VC main interactive application	A-1 SD - SS2	**Passed**
	A-2 SD – CS6	**Passed**
	A-3 SD – SS2	**Passed**
	A-5 SD – CS6	**Passed**
	A-2 PD – CS6	**Passed**
	A-5 PD – CS6	**Passed**
	A-15 PD – SS2	**Passed**
	A-14 HF – SS2	**Passed**
	A-15 HF – SS2	**Passed**
	A-17 HF – SS2	**Passed**
	A-18 HF – SS2	**Passed**
	A-19 HF – SS2	**Passed**
	A-3 IHD – SS2	**Passed**
	A-15 IHD – CS6	Same as A-15-IHD-CS6 – R5.3
	A-18 IHD – SS2	**Passed**
	A-21 IHD – SS2	**Passed**
R3-6: Information Interface	A-1 SD – CS5	**Passed**
	A-2 SD – CS6	**Passed**
	A-5 SD – CS6	**Passed**

	A-5 PD - CS5	**Passed**
	A-15 PD - CS6	**Passed**
	A-12 HF - CS6	**Passed**
	A-13 HF - CS5	**Passed**
	A-15 HF – CS6	skipped
	A-15 IHD – CS6	Same as A-15-IHD-CS6 – R5.3
	A-20 IHD – CS5	Same as A-2-SD-SS1 – R3.10
R3-7: Agenda interface	A-1 SD – SS2	**Passed**
	A-3 HF - SS2	**Passed**
	A-13 HF SS2	**Passed**
R3-10: Weather information	A-2 SD - SS1	**Passed**
R3-11: Standby mode	A-2 PD – SS3	**Passed**
R4-6: Personalized and context-aware interaction and feedback	A-1 SD – CS5	**Passed**
	A-2 SD - CS5	**Passed**
	A-5 PD - CS5	**Passed**
	A-12 HF - CS5	**Passed**
	A-13 IHD - CS5	**Passed**
R5-2: E-learning	A-3 SD – CS4	**Passed**
	A-3 HF – CS4	**Passed**
	A-17 HF – CS4	**Passed**
	A-18 HF – CS4	**Passed**
	A21 IHD – CS4	**Passed**
R5-3: Notification and reminders	A-2 PD – CS6	**Passed**
	A-12 HF – CS6	**Passed**
	A-13 HF - CS6	**Passed**
	A-15 HF – CS6	**Passed**
	A-13 IHD – CS6	**Passed**
	A-15 IHD – CS6	**Passed**
R5-4: Agenda	A-15 PD CS6	skipped
R5-5: Health status	A-1 SD – CS2	**Passed**
	A-2 SD – CS2	**Passed**
	A-1 PD – CS2	**Passed**

	A-12 HF – CS2	**Passed**
	A-13 HF – CS2	**Passed**
	A-14 HF – CS2	**Passed**
	A-17 HF – CS2	**Passed**
R5-6: User feeling	A-1 SD – CS8	**Passed**
	A-2 SD – CS8	**Passed**
R5-7: Medical questionnaires	A-9 SD – CS7	**Passed**
	A-21 IHD – CS7	**Passed**
R5-8: Physical training	A-14 HF – CS1	**Passed**
R7-1: Vital stats control	A-15 HF – DS5	**Passed**
R7-2: Activity tracker, outdoors and indoors physical activity monitoring	A-15 HF – DS5	**Passed**
	A-16 HF – DS5	**Passed**
R7-3: Blood pressure monitoring	A-15 HF – DS5	**Passed**
R7-5: Glucose monitoring	A-15 IHD – DS5	adjusted
R7-6: Cholesterol monitoring	A-15 IHD – DS5	**Passed**

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1. Introduction

1.1 Circumstances statement

Due to restrictions taken in consequence of the Corona pandemic, mostly all partners faced the situation that the offices and laboratory sites were closed (or it was officially forbidden to go there) for some weeks what inhibited all activities related to physical setups such as the full physical implementation of the vCare solution's TechLab prototypes and hampered technical integration works. Some partners faced official reductions of allowed working hours. This slowed the technical implementation works that could not have fully be compensated. Also, the planned study visits at the TechLab sites were not possible due to travel restrictions. The feedback by the medical partners need to be collected in less powerful, remote workshops. Also, the inclusion of patient groups for the foreseen participatory design activities is still not possible and needs to be replaced by making some efforts for 1:1 interview supported by materials like videos outlining vCare's approach. The setup of the TechLabs at the three TechLab sites (partner FZI, Germany; AIT, Austria; MYS, Spain) as originally foreseen was impeded to some extent with regard to the primary technical test and integration works. The particular situation and measures to catch up are summarised below.

- MYS: In Spain, from the technical point of view, the industrial activity has been under lock down since March 15 to June 20. Regarding MYS, as provider of sensing technology this affected to the fact that premises were closed and assembly and testing of software/devices was restricted to existing previous units but the required firmware updates could not be tested until this week (first batch of sensors now assembled, to be received this week). The shipment to the different sites is on hold until units can be assembled during remaining June and July. Additionally, to the lockdown, MYS also suffered a mandatory reduction (government-enforced) on the working hours to 50%, what added some inherent delay in the tasks. To catch up, MYS's approach is to advance on integration efforts in WP7, which is less affected by remote work, and concentrate efforts in WP2 during July. The integration work in WP7 is progressing with some delay due to the COVID-19 situation, but is finished by mid-July the latest. When talking about the TechLab testing, the project in general had to switch to a "virtual" or remote validation taking into account that it has not been possible to assemble a physical demonstrator at the hospitals, that end-users can use.
- AIT: Due to the COVID-19 situation, AIT has introduced mandatory home office for all employees in March 2020. In March and April 2020 entering the AIT facilities was not allowed, in May being at the facilities was allowed under special circumstances. Since beginning of June, AIT employees can enter the facilities without major restrictions and use the infrastructure, even we still work from the home office a lot. For the TechLab activities the situation had a minor impact.
  In the first phase (March and April) AIT could perform the developments also from the home office without facing major obstacles in terms of integrating and testing sub-components of vCare. Even AIT continued working on the sub-components in May, we couldn't start to setup the full system in the lab in time integrating also the hardware components.
  Since we are facing no further restrictions, the full system setup could be started with a slight delay in June.

- FZI: In general, while FZI was able to work from home, the lack of physical meetings at the different locations slowed down the pace of integration, which we think should be highlighted. In particular, FZI experienced restrictions due to COVID-19 which impeded the TechLab progress. As all FZI employees have been (and still are) forced to work from home, it was not possible to conduct physical meetings with both technicians (in order to effectively work on an integrated infrastructure) as well as medical experts (in order to model realistic patient simulations and expert rules). Although most communication between the partners involved in the TechLab was done remotely, the resulting slower-paced integration lead to delays in the possibility to conduct appropriate test cases, which are essential for D1.6.
While significant progress has been made with respect to the overall technical integration as well as the realization of the vCare vision, the shortcomings of exclusively communication over virtual channels became apparent, where essential technical interfaces needed to be aligned in bilateral online meetings, requiring several iterations per interface. To conclude, although FZI expected to be able to continue to work on all necessary aspects to lead the completion of D1.6, the additional time needed for integrating and testing the Tech Lab components was underestimated. However, we caught up to avoid fast, unsustainable solutions and to properly document the successful testing of the first technical integration of vCare with respect to the test cases in D1.6. The latter ensures that all technical components are aligned and work properly, where global runs of the vCare system can be tested physically as soon as the COVID-19 situation becomes better.

1.2 DOCUMENT STRUCTURE

The document is divided into 8 chapters. The current chapter, (***1. Introduction***), deals with the framework in which **D1.6** is integrated. In particular, the influence of the current pandemic on the affected partners and their working practices was discussed (***Circumstances statement***

).

In the next subchapter we give a short summary of the idea of the TechLab as defined in **D1.5.** Based on this, we will discuss the implementation of the tech labs. Individual reports on the implementation of the individual Tech Labs sites are presented (see section ***2. Realisation of*** the TechLabs).

The following **chapter *3*** is dedicated to the implementation of the participatory designs. Here, inputs from different medical partners are presented.

In **chapter *4*** we present some showcases that show the technical components of the vCare architecture. For the sake of completeness, components such as the pathway modeler are also shown, but the focus is on the presentation of the technical components, which will require documentation in the later test execution.

In addition, **chapter 5** deals with the conceptual procedure during the TechLab and the following chapter documents the exact time of implementation (**chapter 5.1**).

The main part of this document is dedicated to the documentation of the test executions, which is summarized in **chapter 6**. Besides the validation of the tests described in **D1.5**, extensive information about the adjustments and findings during the entire TechLab time is aggregated in **chapter 7**. In addition to the technical integration via the data flow charts, the medical validation and adaptation of the test cases is also addressed.

The document is rounded off by a conclusion and outlook on the next steps during the living lab in **chapter 8**.

1.3 Planned Activities during TechLab in General

At the beginning of this document we want to give an overview of what was planned for the Tech Lab in **D1.5** in order to evaluate the achievement of the respective goals during the realization of this phase.

This phase is focused on validating the technical components. On the one hand, the focus is on **Task 1.4**, which comprises the finalization of the technical core components and the integration of the defined requirements. Looking at the result of these two tasks, it should be tested in a controlled environment to ensure that the technical concept meets the requirements and provides a functional basis from a technical perspective for the overall project.

While phase two targeted to provide a conceptual prototype, phase three aimed at a preliminary technical prototype.

The core tasks of the TechLab deal with the topics:

- Hardware and software development and testing
- Sensor connection
- Data integration and analysis

Specific ones are defined as implementation goals of this phase:

- Main information flows between layers implemented
- Middleware and knowledge mediator integrated and operational.
- Telemonitoring devices fully operational and integrated
- Smart-Home system developed, and devices integrated
- Intelligence capabilities ready to support and execute algorithms
- Identified coaching services and apps up and running

The attached graphic is taken from the deliverable D1.5 and describes the entire process in which this deliverable is integrated. Based on the previous phase 1, in which the requirements were analyzed and placed in the context of the later planned use, the TechLab phase deals with phases 2 and 3.

Phase 2 is about defining a conceptual prototype. During the development process itself, close cooperation with the medical partners should then take place. In the original **D1.5,** the integration of patients in the form of a Think Aloud Study and the collection of a Qualitative Usability Survey was planned.

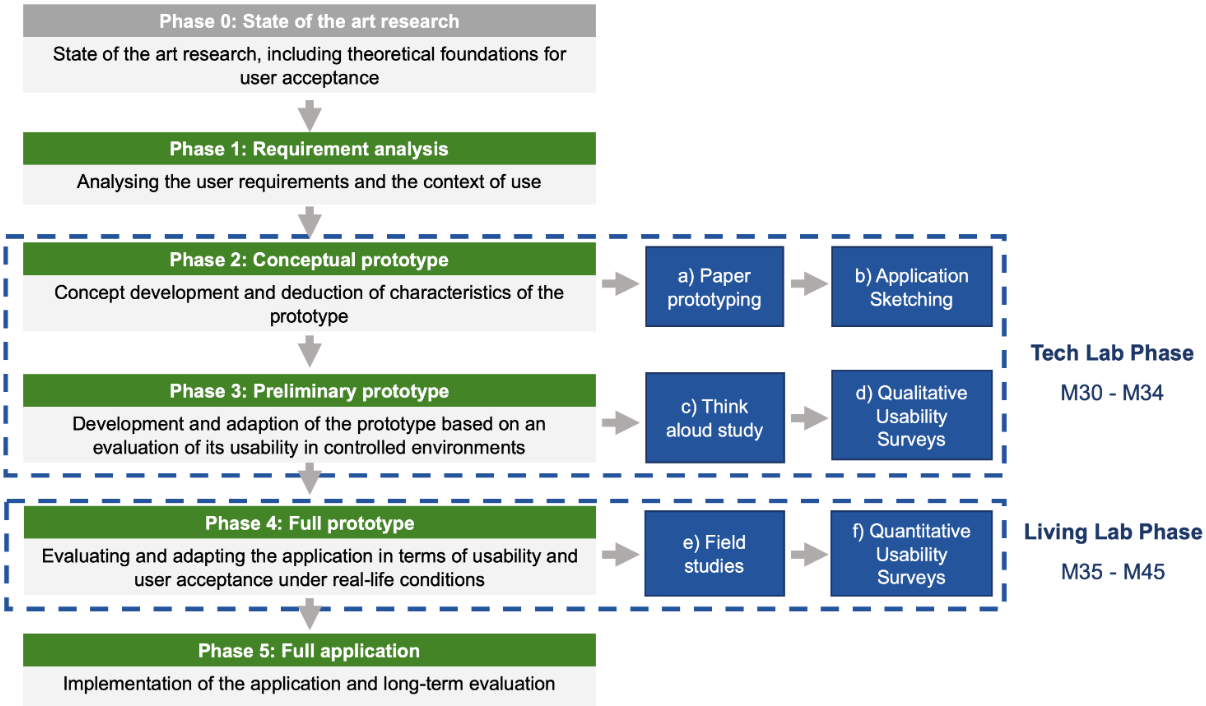

Figure 2: Phases Tech Lab and Living Lab

The TechLab phase thus has the primary goal of advancing the development of the core components and providing medical experts with access to the system and involving them in the development process. On a technical level, the main goal is to define where and how information is processed and passed on.

2. Realisation of the TechLabs

As already described in the introduction, the implementation of the TechLab phase took place under special circumstances due to COVID-19. Especially the construction of extensive test environments at the institutes or medical facilities was only possible to a limited extent due to such protective measures. In the following, we will therefore go into detail about the different implementations in the defined phase at the individual locations and then give a general overview of the achievements of the phase.

2.1 Report TechLab Austria (AIT)

The work in Wiener Neustadt at the AIT site has focused on developing the coaching services and the communication between the coaching services layer with the Knowledge Layer and the UI layer. On a general level, the aim was to implement the following workflows:

- Receiving coaching services requests from other layers (mainly the Knowledge Layer)
- Generating user interaction requests within the coaching services layer to be sent to the UI layer
- Receiving, reacting, and responding to requests within the UI layer
- Reacting to user input in the UI layer and sending to and processing those requests at the coaching services layer.

The remainder of the section is explaining the points mentioned above in more details, the approach of organizing the tests is described. On the one hand, the structure of the content of the MQTT messages as defined of deliverable D5.3 has been refined resulting in an updated version of this living document, and on the other hand, the message flows of the tests as defined in deliverable D1.5 have been analysed and clustered according to their services involved and their message flows. Hence, test cases in the same cluster involve the same services and message topics as defined in D5.3 but might differ in the content of the message. An overview of the message flows and the related activities and tests respectively, is given in the following Table 3:

Table 3: Clustering of the message flows (MF X) of the test cases as described in D1.5. [3]

Message flow #	Message flow	Test cases
MF 1	User -> Speech input - > Supporting Service -> Output	A-1 SD - SS2 R3-1 A–3 SD – SS2 R3-1 A-14 HF -SS2 - R3-1 A-15 HF – CS6 – R5-3

[3] Some test cases consist of two message flows in sequence, hence those cases are listed twice. Test cases which are already stated as duplicates in D1.5 (“*Already tested…*” notes) are not listed here for the sake of simplicity.

		A18 IHD – SS2 R3-1 A-21 IHD – SS2 R3-1 A-1 SD – SS2 – R3-7 A-13 HF – SS2 R3-7 A-2- SD - SS1- R3-10 A-3 – SD – CS4 – R5-2
MF2	Reasoner -> Reminder message -> output - > USER -> speech or text input -> Reminder response -> Reasoner	A-2 SD – CS6 – R3-1 A-5 PD – CS6 – R3-1 A-15 PD - CS6 – R3.6 A-15 HF – SS2 – R3-1 A-17 HF – SS2 – R3-1 A-2 SD – CS6 – R3-6 A-2 PD – CS6 – R5-3 A-14 HF – CS1 - R5-8 A-18 IHD – SS2 R3-1
MF3	Reasoner -> health questionnaire -> output -> USER > health questionnaire -results -> reasoner	A-1 SD – CS8 – R5-6 A-2 SD – CS8 – R5-6 A-9 SD – CS7 – R5- 7 A-21 IHD – CS7 – R5-7
MF 4	Game Session or User input -> Health status request -> health status message - > output	A-3 SD – SS2 – R3-1 A-5 SD – CS6 – R3.1 A-12 HF - CS6 – R3-6 A-3 SD – CS4 – R5-2 A-1 SD – CS2 – R5-5 A-2 SD – CS2 – R5-5
MF 5	Reasoner -> dialog output request -> dialog output	A-3 HF – DS7 – R2-9 A-15 HF – CS2 A-18 HF – SS2 – R3-1 A-19 HF – SS2 – R3-1 A-1 SD – CS5 – R3-6

		A-2 SD – CS6 – R3-6 A-13 IHD – CS6 – R5-3 A-15 IHD – CS6- R5-3 A-15 IHD – DS5 – R7-6 A-14 HF – CS2 – R5-5
MF 6	Reasoner -> e-learning -content message -> output -> USER confirmation -> start e learning session	A-3 IHD – SS2 – R3-1 A-3 HF – CS4 – R5-2 A-17 HF – CS4 – R5-2 A-18 HF – CS4 – R5-2 A-21 IHD – CS5 – R5-2 A-3 SD – CS4 – R5-2
MF 7	USER input -> standby message -> trigger after delay -> standby message	A-2 PD – SS3 – R3-11
MF 8	Reasoner -> Reminder - > Motivation output request -> Reminder -> output	A-13 HF – CS6 – R3-6
MF 9	Reasoner -> motivation text request -> Motivation text generation -> reminder message -> output	A-12 HF – CS6 – R5-3
MF 10	CS6 -> Reasoner -> Reminder message -> USER response -> Reasoner	A-5 PD CS5 – R3-6
MF 11	SS2 -> Agenda list request -> KIOLA via REST Agenda list response	A-14 HF – SS2 – R3-1 A-21 IHD – SS2 – R3-1 A-3 HF - SS2 – R3-7 A-13 HF SS2 – R3-7

Receiving coaching services requests from other layers (mainly the Knowledge Layer)

The tests have been performed in close cooperation with the other partners who are responsible for the other layers, mainly FZI. Based on the message flows as described in Table 3, the single messages, based on the definition in D5.3, have been tested.

Generating user interaction requests within the coaching services layer to be sent to the UI layer

The messages as foreseen in the message flows for triggering the coaching services have been sent manually to test its processing by the respective service and to observe the foreseen user interaction on the UI. These tests have been performed also in an integrated way by receiving the triggers from the Knowledge Layer.

Receiving, reacting and responding to requests within the UI layer

Within this category the delivery of messages and requests to be displayed on the UI (notifications, reminders, questionnaires) triggered from the backend have been tested. The tests included the trigger of the messages and the response by the user.

Reacting to user input in the UI layer and sending to and processing those requests at the coaching services layer

Triggers foreseen from the user side have been tested by using the interaction modalities of the UI (speech and touch). The purpose of these tests was mainly to check if the respective coaching service received the request and respond accordingly.

2.2 Report TechLab Spain (MYS)

The work in Spain has been focused on the integration of data in WP2 and WP7, and the home-side algorithms for activity and behavior detection.

The testing has been conducted under lab conditions, since most of the data is time dependent and test cases span wide periods. To be able to run tests, a series of simulated events have been used as triggers to execute the logic of algorithms.

For the validations, the main effort has been assumed by MYS, but interaction with other components in the vCare system required that SIV, IMA, FZI and AIT participated in the definition of input/output messages. All the communication has been done using the MQTT middleware deployed in the context of WP7.

Part of the TechLabs testing has been devoted to the setup of security and access from the different services in vCare system to the MQTT broker. The activities performed in that regards have been:

- Creation in Keycloak of clients that each service can use to authenticate and get access tokens.
- Helping each partner connect their services through a MQTT client library.
- Define the template of exchanged messages (continuing the work in D5.3)
- Define all the possible topics in MQTT and the data that should flow through them, extending the work already published by WP5.

The newly defined topics are:

Table 4: data topics defined in the MQTT middleware

Complete topic label	Description
vcare/<<patientId>>/careplan/assigned	message issued when a new careplan is assgined to a patient
vcare/<<patientId>>/careplan/modified	message issued when a careplan has been modified and clients are notified with an update
vcare/<<patientId>>/careplan/unassigned	message issued when a careplan is removed/unassigned from a patient
vcare/<<patientId>>/careplan/current/request	message issued by a client requesting the active careplan of a patient
vcare/<<patientId>>/careplan/current/response	message issued to response a careplan request
vcare/<<patientId>>/careplan/history/request	message issued by a client requesting the history of treatments assigned to a patient
vcare/<<patientId>>/careplan/history/response	message responding a careplan history request
vcare/<<patientId>>/patient/profile/created	Used to broadcast new patient profiles created in vCare
vcare/<<patientId>>/patient/profile/updated	Used to broadcast updates to a patient profile
vcare/<<patientId>>/patient/profile/deleted	Used to notify the deletion of a user profile
vcare/<<patientId>>/patient/profile/request	Used to request a specific patient profile
vcare/<<patientId>>/observation/<<obsType>>	Used to exchange data about a specific observation type. The <<obsType>> variable correspond to any vital signs/attribute defined in the vCare ontology (D4.3)
vcare/<<patientId>>/observation/history/ <<obsType>>/request	Used to request historical data about a specific observation type
vcare/<<patientId>>/observation/history/ <<obsType>>/response	Used to answer to a request
vcare/<<patientId>>/activity/<<actId>>/started	Used to notify that a certain activity in the careplan has started
vcare/<<patientId>>/activity/<<actId>>/finished	Used to notify that a certain activity in the careplan has finished
vcare/<<patientId>>/device/assign	Used to assign a device to a patient
vcare/<<patientId>>/device/unsassign	Used to unassign a device to a patient
vcare/<<patientId>>/device/list/request	used to request the device list for a patient

vcare/<<patientId>>/device/list/response	Used to answer a previous device list request
vcare/<<patientId>>/clinicalstate/request	Used to request the clinical state of a patient
vcare/<<patientId>>/clinicalstate/response	Used to answer to a clinical state request
vcare/<<patientId>>/clinicalhistory/request	Used to request the clinical history of a patient
vcare/<<patientId>>/clinicalhistory/response	Used to answer to a clinical history request
vcare/<<patientId>>/personalstate/request	Used to request the personal state of a patient
vcare/<<patientId>>/personalstate/response	Used to answer to a personal state request

In Table 4, generic topics are defined. All topics use the patient Id as part of the topic name to grant access to the contents to these clients that have permission to access data of such patient.

Other topics use substitution variables to interpret the data flowing through them. The most important is 'obsType', which can take any of the values defined in vCare ontology for measurements related to the patient. E.g., to exchange heart rate data, the concept in the ontology is 'vcs:heartRate'. The definition of the topic uses the concept in snake case[4]. The specific topic for heart rate would be:

vcare/<<patientId>>/observation/heart_rate

Using this strategy, new observations types added to the ontology are automatically mapped to MQTT topics.

[4] https://en.wikipedia.org/wiki/Snake_case

2.3 Report TechLab Germany (FZI)

The work at the Karlsruhe site has focused on advancing the processing and presentation of knowledge in the Knowledge Layer. On a general level, the aim was to implement and evaluate the complete workflow of:

- Automatically receiving (e.g. patient or device data) from other layers,
- Lifting data to the structure of the vCare ontology through semantic wrappers,
- Processing the resulting information for analyzing and adapting clinical pathways,
- Automatically providing the enriched information to respective layers such that, for example, the coaching services can display the results

On the one hand, this has been done on a conceptual level by further defining and providing the final ontology **(D4.3)**. Adaptation of the ontology have different origins here. On the one hand, changes are motivated by technical aspects. This was the case when information provided by other technical partners could not yet be fully mapped in the ontology. Here the modular structure of our ontology has proven itself, which allows the adaptation and extension of the approach in an efficient way. In addition to the technically motivated extensions, the ontology has been further specified in order to define further clinical pictures.

In parallel to the definition of the ontology, the adjustments to the corresponding interface have taken place. Here we are talking about the wrapper. The information received is extracted from the JSON format and stored in our knowledge database, which is based on the anthology. The knowledge base is a RDF graph, which semantically processes information and can thus represent complex relations and interrelationships.

Knowledge aggregation plays a decisive role in the context of knowledge processing. The extensive integration work in the TechLab phase was relevant here. In addition to the question of what is to be communicated, i.e. passed on as information, the question of how it is to be transported is also decisive. While the general format in which the knowledge layer receives its information was already defined at the beginning of the phase, JSON files, far-reaching progress was made in this phase on how the information is exchanged. For this purpose, the integration via an MQTT broker is used, to which several technical partners can connect and to which several technical partners can connect, and both provide and receive information.

Based on the information aggregation, whose structure is largely defined by the ontology, the knowledge layer serves the interface to other coaching services. Here, for example, it is about sending a reminder to the patient or triggering the start of a health questionnaire. Detailed information about the individual interfaces and applications can be found in the detailed documentation of the individual test cases.

How exactly the information stored is processed and which services are started based on it is part of the reasoner. While rules, such as those for exceeding a pain threshold, are clear and easy to define, we have also discussed the modelling of more complex relationships with our medical partners during the TechLab phase. In an intensive exchange, for which the constantly expanded ontology provided an excellent basis, we were able to define additional so-called expert rules.

For example, we were able to further differentiate that the clinical parameter ROM should be divided into different body parts. On the one hand, a value that refers to the hip, on the other hand a value that specifies the knee and lastly a value that defines the ankle. For each of these attributes we have also defined ranges of values and divided them into different clusters. An example of this can be found in the following table:

Table 5: Expert Rules Motor Status

Motor status		Values	Subset
ROM	lower limb, hip	hip flexion[0°-120°] hip extension [0°-30°] hip abduction [0°-45°] hip adduction [0°-30°] hip internal rotation [0°-30°] hip external rotation [0°-45°]	for each move: **Low**: [ROM <=1/3 comparing with full physiological joint rom] **Medium** [1/3<ROM<=2/3 comparing with full physiological joint rom] **High** [2/3<ROM<=3/3 comparing with full physiological joint rom]
ROM	lower limb, knee	knee flexion [0°-140°] knee extension [140°-0°]	for each move: **Low:** [ROM <=1/3 comparing with full physiological joint rom] **Medium** [1/3<ROM<=2/3 comparing with full physiological joint rom] **High** [2/3<ROM<=3/3 comparing with full physiological joint rom]
ROM	lower limb, ankle	ankle dorsal flexion [0°-20°] ankle plantar flexion[0°-50°]	for each move: **Low**: [ROM <=1/3 comparing with full physiological joint rom] **Medium** [1/3<ROM<=2/3 comparing with full physiological joint rom] **High** [2/3<ROM<=3/3 comparing with full physiological joint rom]
Mini-Best	balance	[0,28]	**Low** [0-18] **High** [19-28]
ARAT	upper limb	[0,57]	**Low** [0 - 20] **Medium** [21 - 30] **High** [31 - 57]

Table 6: Expert Rules Pain and Exertion Status

Pain and exertion status		**Values**	**Subset**
VAS	pain level perceived	[0,10]	**Low** [0 -3] **Medium** [4-7] **High** [8-10]
Borg	exertion level perceived	[0,10]	**Low** [0 -3] **Medium** [4-7] **High** [8-10]

Based on the defined ranges and categories for each of the attributes we then defined more precise Expert rules. Those rules lay ground to the reasoner and ensure that the smart agent only suggest safe activities.

Complex rules can apply to activities and look as followed (Table 6):

Table 7: Expert Rules activity related

Activity	**Value**	**Threshold**	**Frequency**	**Consequence**
walking	ROM; Mini Best; borg	**IF** *at least one* (ROM hip) is <u>low</u> **OR** *at least one* (ROM knee) is <u>low</u> **OR** *at least one* (ROM ankle) is <u>low</u> **OR** (MiniBest) is <u>low</u> **OR** (current Borg) is <u>high</u>	daily (morning)	Feedback to <u>no walking</u>
	ROM; MiniBest; borg	**IF** [*all (ROM* hip) are <u>medium</u> OR <u>high</u> **AND** *all* (ROM knee) <u>medium</u> OR <u>high</u> **AND** *all* (ROM ankle) <u>medium</u> OR <u>high</u> **AND** (MiniBest) is <u>high</u> **AND** (current Borg) is <u>medium</u>	daily (morning)	VC proposes <u>10 minutes</u> of walking
	ROM, Mini Best, Borg	**IF** [*all (ROM* hip) are <u>medium</u> OR <u>high</u> **AND** *all* (ROM knee) <u>medium</u> OR <u>high</u> **AND** *all* (ROM ankle) <u>medium</u> OR <u>high</u>	daily (morning)	VC proposes <u>20 minutes</u> of walking

	AND (MiniBest) is <u>high</u> **AND** (current Borg) is <u>low</u>

Or can be defined on a general level and look like the following example (Table 7):

Table 8: Expert Rules lifestyle related

Value	Threshold	Frequency	Consequence
daily time of inactivity	<=4 h	end of day	VC give **POSITIVE feedback**
	4 h< daily time of inactivity <=6 h	end of day	VC give **Negative warning feedback** addressed to user **and suggestions** to consult daily agenda for extra physical activity sessions (21 min) with serious games
	6 h< daily time of inactivity <=12 h	end of day	VC **investigate** mood and pain status through facial expression detection and VAS self-administration

2.4 Limitations to the integration of devices

During the integration phase, some issues were found in the selected set of devices to integrate that have forced a reassessment of some of the requirements.

The most relevant case is related to the electronic pillbox device, which is referenced by **R7-7**, medication adherence monitoring.

In **D7.4**, a pillbox was identified, the Tricella one. We approached this manufacturer to query about the integration of their pillbox, but they did not offer an API to extract the data. Their own solutions had to be used, which was not acceptable for the vCare.

We repeated a search of devices and found several possible candidates:

Tinlylogic

Table 9: pillbox Memo Box Mini

<table>
<tr><td rowspan="4">Pillbox</td><td rowspan="3">Tinlylogic Memo Box Mini</td><td></td><td rowspan="3">- Connectivity: BT, MedsOnTimeTM Enterprise SDK/API License
- Capacity: 1day, 3 compartments</td></tr>
<tr><td>Estimated Price</td></tr>
<tr><td>37EUR</td></tr>
<tr><td colspan="3">Link: https://www.amazon.es/dp/B071J5PV84?m=A2OCZ4C2CFCZEN&ref_=v_sp_detail_page</td></tr>
</table>

Table 10: pillbox Memo Box Deluxe

<table>
<tr><td rowspan="3">Pillbox</td><td rowspan="3">Tinlylogic Memo Box Deluxe</td><td></td><td rowspan="3">- Capacity: 4 compartments
- Connectivity: BT, MedsOnTimeTM Enterprise SDK/API License</td></tr>
<tr><td>Estimated Price</td></tr>
<tr><td>90 $</td></tr>
</table>

<table>
<tr><td></td><td>Link: https://pillbox.tinylogics.com/products/memo-box-deluxe</td></tr>
</table>

Table 11: pillbox Memo Box Vibrant

<table>
<tr><td rowspan="4">Pillbox</td><td rowspan="3">Tinlylogic Memo Vibrant</td><td></td><td rowspan="3">- Capacity: 2/4 compartments
- Connectivity: BT, MedsOnTimeTM Enterprise SDK/API License</td></tr>
<tr><td>Estimated Price</td></tr>
<tr><td>65 $</td></tr>
<tr><td colspan="3">Link: https://pillbox.tinylogics.com/products/memo-box#description</td></tr>
</table>

Elliegrid

Table 12: pillbox Elligrid

<table>
<tr><td rowspan="5">Pillbox</td><td rowspan="3">Elliegrid</td><td></td><td rowspan="3">When it's time to take your pills, an alarm on the device will ring and a light will start flashing. Whenever you open the device, specific lights will turn on indicating which pills you should take and how many

Integration: pillbox communicates with a phone running an app via BT. Data can be retrieved later on from a WEB API</td></tr>
<tr><td>Estimated Price</td></tr>
<tr><td>150USD</td></tr>
<tr><td colspan="3">Link: https://elliegrid.com/products/ellie-smart-pill-box</td></tr>
<tr><td colspan="3">Additional costs in the access to the API:
— $0.99/week if you just want access to reports
— $1.99/week if you want access to reports and want caregivers to receive notifications.</td></tr>
</table>

Vaica

Table 13: pillbox SimpleMed+

Pillbox	**SimpleMed+**		An advanced medication managing and reminder system. Designed to combine patient's ease of use with various options for the service provider; thus making it the most effective and efficient solution for improving medication adherence. SimpleMed+ makes use of auditory & visual alerts to remind a patient to take the right medication in the correct manner, at the designated time. In a case that the medication was not taken, the service provider is informed for further action.
		Estimated Price	
		268 USD	
	Link: https://www.vaica.com/simplemed/		
	Additional costs in the access to the API: — You have to purchase CPS-S small cloud platform services (min 50 devices), with a monthly cost of 750 USD.		

We approached the 3 vendors, with the following outcome:

- **Tinlylogic**: after several attempts, we never received feedback from them.
- **Elliegrid**: the most advanced device of all, this company based in USA offered us an API access to the data generated from their devices. That means that we were required to use their own app and the data would be hosted in USA (implying the data going out the European borders). The API was charged 1$/week/device, which was assumable by the project, but the data flowing out of Europe was assessed as a possible risk in the context of the GDPR.
- **Vaica**: this company, based in Israel, provides devices which transfers data to their servers using an e-SIM and 3G connectivity. To access the data, we were forced to buy their professional platform (aka, CPS-S), which could be deployed in a server inside Europe to avoid problems with the GDPR. We asked for budget and the offer received was assessed by the project as not 'cost/effective': we were asked 25.000 euros to deploy the pillbox and the professional portal. Although the budget could be assumed by the project, the future exploitation model was not viable.

The negotiations with all the vendors were discussed with the medical board to assess the best solution, but none of them was appropriate for vCare. As a result, it was decided that the medication adherence monitoring would be done using a completely different approach: interactions with the avatar, asking the patient whether he/she took the prescribed medication. This strategy needs a proper reformulation to define when and how the avatar will be interacting with the patient.

This change in strategy has collaterals on some of the test cases which were related to the integration of the pillbox:

- A-15 PD, CS6 R2-8, CS6 R2-7, CS6 R3-6, CS6 R5-4
- A-15 HF, CS6 R2-8, CS6 R2-7, CS6 R5-3, CS6 R3-6,
- A-15 IHD, DS5 R7-7

These test cases will need a reformulation to adapt them to the new strategy about medication monitoring and will be reported in later versions of the test cases (e.g., D1.7).

3. Participatory Design – Tech Lab Phase

When developing healthcare technologies, acceptability and usability should be evaluated by end-users (i.e., medical staff and patients) throughout the development phases, in order to guide the design process by tailoring the users' specific needs, and to reduce the risk of non-acceptance. For this reason, as described in D1.5, the process of involvement of the users in the design/testing of the vCare prototype is spread along the three different main phases of the project: Tech Labs, Living Labs, and Pilot Test.

This chapter reports the methods and the results of the Participatory Design, i.e. the involvement of users, during the Tech Labs Phase (Task 1.4, "Study Design in a Tech Lab").

In Participatory Design activities during Tech Labs, end-users were asked to give their impressions, reactions and feedback about the vCare system, after a presentation of the service through a mock-up consisting of a video footage.

The purpose of the involvement of the target population in this phase was to collect initial valuable feedback about the system in order to guide the development of the vCare features (e.g. user friendliness). The main goal was to provide some initial knowledge background about general impressions of the vCare system and its potential. These preliminary results will allow to plan the refinement process of the solution throughout the entire Living Lab Phase, according to end-users' feedback and likings.

Users involvement will intensify in the next phases (i.e. Living Lab Phase and Pilot Test Phase), where patients will be able to concretely test the solution and contribute in the co-design process more actively. This method should help ensuring that the final version (delivered within the Pilot Phase) will meet end-users' needs and will be usable in a real domestic environment.

3.1 Background

Globally, participatory design activities have been planned so that the end-users will take part in the innovation process and in the co-creation of the solution, depending on the level of involvement which can be reached.

As described in D1.5, the Participatory Design methods and interventions in the Tech Lab phase have been divided into **four stages**:

- Paper Prototyping
- Application Sketching
- Think aloud study
- Qualitative Usability Survey

These four stages are derived from the general six-phase model[5] for a Participatory Design process thoughout the lifecicle of a healthcare IT, described in D1.5 and reported in Figure 3. The phases linked to the Tech Lab phase are highlighted.

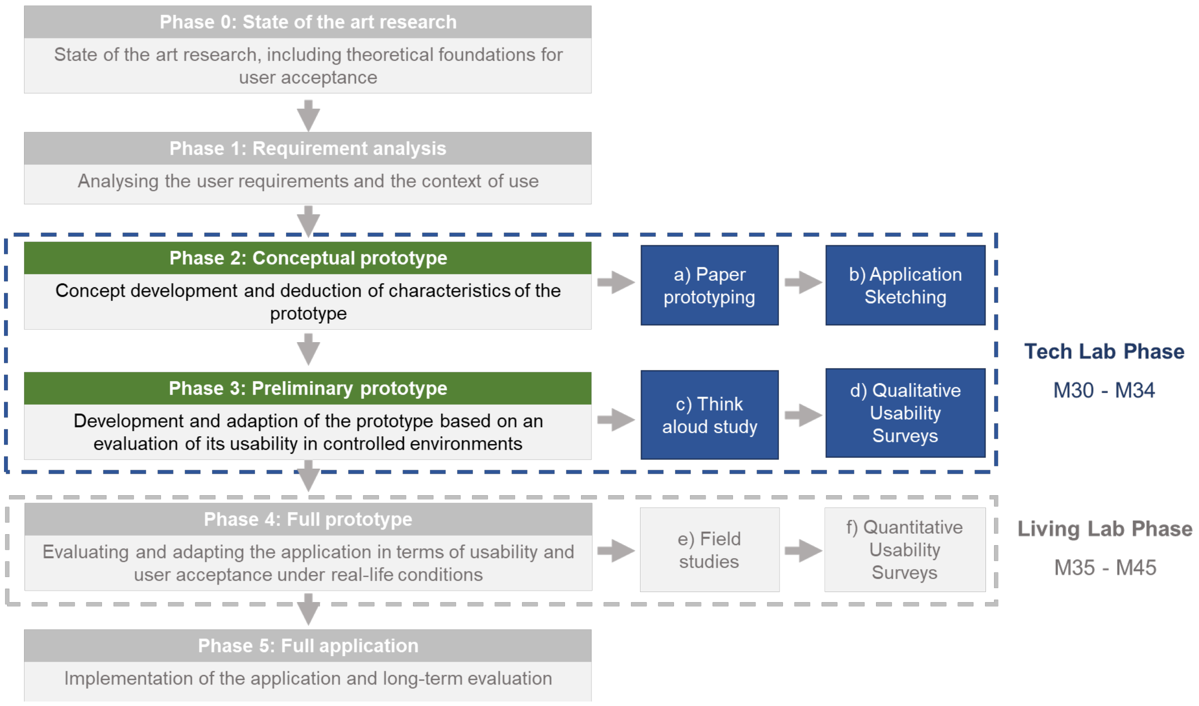

Figure 3: The Consolidated Phase Model for User-centred Design Processes (Harst et al, 2005). The phases linked to the Tech Lab phase are highlighted.

The methods and results of Participatory Design activities of the clinical pilots during Tech Lab Phase are presented in the following sections.

3.2 Materials and Methods

The methods and interventions used in the four stages of the process during Tech Labs are schematized in Figure 5 and briefly described in the following sub-sections. The grey rectangle in the figure marks the two stages in which patients are directly involved.

[5] Harst L, Birnstein J, Wollschlaeger B, Fuchs T, and Timpel P. 2020. " User-centered design procedures throughout the lifecycle of healthcare IT – a stepwise methodological perspective". (under submission)

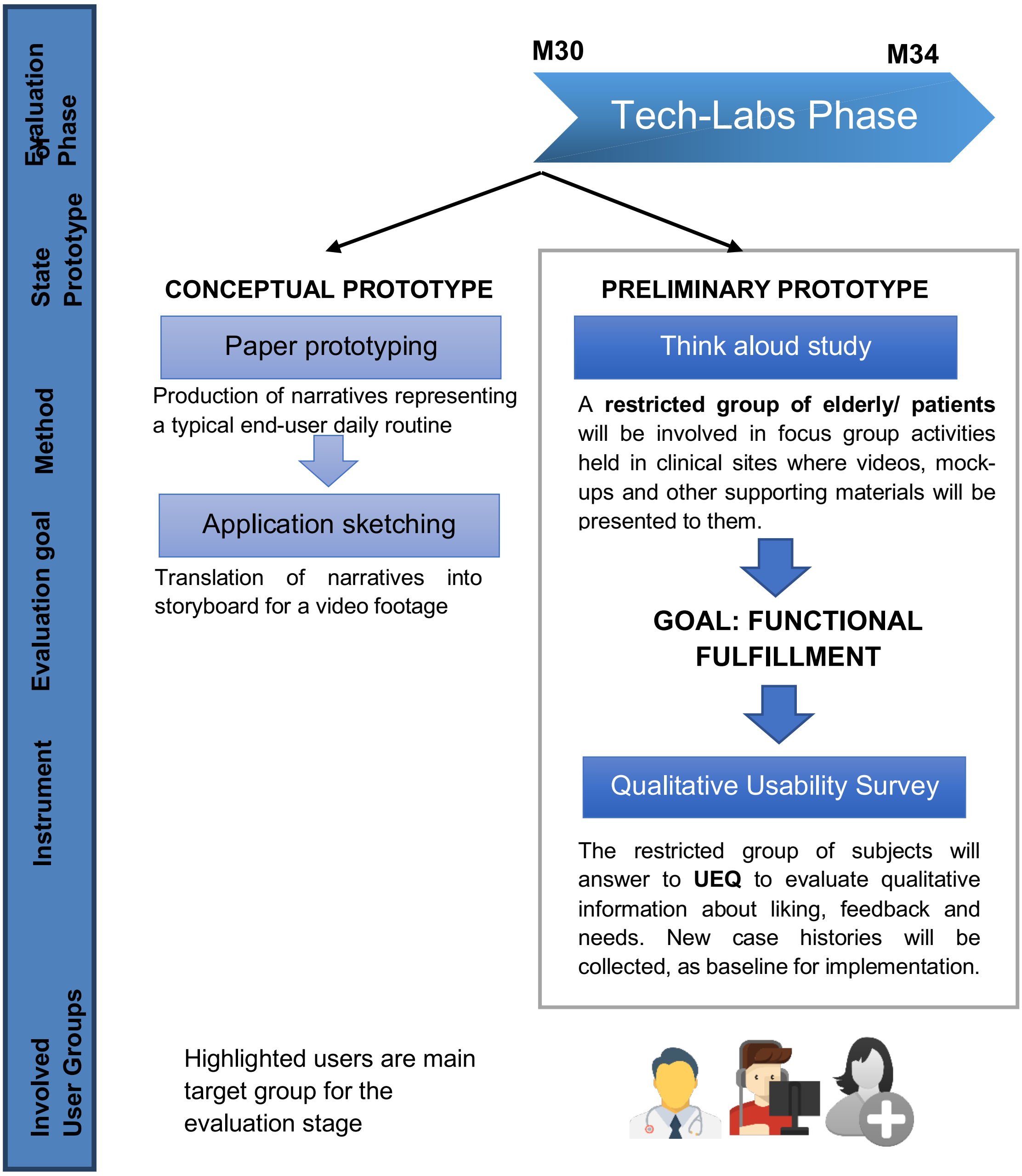

Figure 5: Participatory Design methods in Tech Lab Phase

3.2.1. Phase 2: Paper Prototyping and Application Sketching

The aim of the *Conceptual Prototyping Phase* (Phase 2 of the general six-phase model, see Figure 3) was to create a video footage by each clinical centre to be specifically used in Participatory Design activities involving the vCare end-users.

Due to COVID-19 pandemic, the entire process flow has undergone a delay with respect to the planned timeline, especially for what concerns the video shootings and footage production, due to the impossibility of accessing the clinical facilities in March and April 2020.

During the **paper prototyping stage**, to support the co-design process, the clinical teams produced materials (e.g. narratives) that illustrated vCare Services and functionalities interactions with the elderly subjects (D1.5, Annex 7.3).

During the **application sketching stage**, the produced narratives were converted into a storyboard for a video footage (see Annex 9.1). This video footage was meant as a presentation of the vCare system and its functionalities, in a phase where end-users aren't yet able to directly experience the system itself. The purpose of the video is to allow each patient to actually figure him/herself in the different situations described.

3.2.2. Phase 3: Think aloud study and Qualitative Usability Survey

The *Preliminary Prototype phase (Phase* 3 of the general six-phase model, see Figure 3) is the first phase in which end-users were directly involved.

During the **think aloud study**, a restricted group of elderly/patients has been involved. They were introduced to the system's features and functionalities through the video footage produced in the previous Phase.

At the end of the think aloud study, the **User Experience Questionnaire** (UEQ, see Annex 9.2) was administered to subjects, to collect first global impressions about the vCare system. The questionnaire consists of 26 items, built as pairs of contrasting attributes that may apply to the product; the user has to express his/her agreement through such attributes. For each item, the order of the positive and negative term is randomized in the questionnaire. Per dimension, half of the items start with the positive and half with the negative term. Each pair of items can be scored from 1 to 7 and then scaled from -3 to +3. Thus, -3 represents the most negative answer, 0 a neutral answer, and +3 the most positive answer.

The UEQ 26 items can be grouped in six domains:

- *Attractiveness:* Overall impression of the product. Do users like or dislike the product?
- *Perspicuity:* Is it easy to get familiar with the product? Is it easy to learn how to use the product?
- *Efficiency:* Can users solve their tasks without unnecessary effort?
- *Dependability:* Does the user feel in control of the interaction?
- *Stimulation:* Is it exciting and motivating to use the product?
- *Novelty:* Is the product innovative and creative? Does the product catch the interest of users?

The *Attractiveness* domain has 6 items, all other domains have 4 items. The clustering of the items is meant to measure both *classical usability aspects* (efficiency, perspicuity, dependability) and *user experience aspects* (originality, stimulation). Because of the construction of the questionnaire, an overall score (for example the mean score over all domains) would make no sense, as it would not be suitable for any proper interpretation. Therefore, data belonging to the six domains were analysed separately.

After the UEQ administration and according to users' ratings on the questionnaire, a qualitative survey was carried out to explore in depth the users' motivations behind the UEQ scores they'd given. This open feedback helped to gather a first general feeling about the solution, to be used as initial knowledge background for the system refinement in later stages.

The methods carried out by each clinical centre are detailed henceforth.

Participatory Design Methods in CCP

Enrolment of subjects

In CCP, the first step of the enrolment process foresaw the participation of 10 subjects respecting the following **enrolment criteria**:

- age > 65 years old
- either stroke affected or healthy (2 groups)
- able to express a consent to watch a demonstration video (shared via web link) through personal digital devices
- able to express a consent to be remotely interviewed through telephone or video chat applications by a Healthcare Professional

The selection of the potential participants has been conducted within local community of older healthy adults and by checking the past hospitalization lists of CCP.

Activities implementation

Due to COVID-19 pandemic and because of the safety rules imposed by CCP's clinical management, this Phase was postponed by a few weeks, for the impossibility of hosting face-to-face focus groups (as originally planned in D1.5) and for the delay in the video production. To limit further delays, in clinical centres the focus groups were replaced by Remote Interviews.

Once the enrolment process was over, end-user involvement in the evaluation of vCare was carried out according to the following 5 steps:

- *Step 1: First colloquial phone call*
  In a first colloquial phone call, with each potential participant, the general aim of the vCare project was clarified by the investigator and further details regarding the end-user involvement in the co-creation process of vCare service were presented.

- *Step 2: Video sharing*
  An e-mail was sent directly to the subject or to his/her caregiver, to share the demonstration video. Afterwards, each involved subject was asked to watch the vCare storytelling video on their own, through personal devices.

- *Step 3: Remote Interviews Instruction*
  Thereafter, with a last contact by phone, the interviewer checked the video receipt and scheduled the remote interviews for the upcoming days.

- *Step 4: User Experience Questionnaire and open feedback*
  At this stage, the CCP clinical staff administered, by phone, the **UEQ** questionnaire. The interviewer could support the subject with the compilation of items only in case of difficulties, avoiding any bias action. After administering the questionnaire, the

interviewer identified (by the items score) the main critical issues highlighted by respondents and he/she proceeded with a semi-structured interview with qualitative output, to investigate in depth the reasons of the most critical issues.

- *Step 5: In depth review analysis*
  All the UEQ scores and feedback were analysed in depth and the results are reported in section 3.3.

Participatory Design Methods in OSA

Enrolment of subjects

For Parkinson's Disease, the enrolment criteria were the following.

Inclusion criteria:

- Patients diagnosed with Parkinson's disease according to established clinical criteria (Brain Bank of London) with an index of Hoehn and Yahr between 1 and 3
- Healthy caregivers of PD patients
- Able to express a consent to watch a demonstration video

Exclusion criteria:

- Patients diagnosed with atypical Parkinsonism
- Patients diagnosed with cognitive impairment
- Specifically exclude bedridden or highly dependent patients
- Patients with other chronic diseases such as heart failure, severe lung, or liver problems.
- Patients with severe psychiatric problems such as hallucinations or major depression
- Patients with poor adherence to previous pharmacological or rehabilitative treatment.

Activities implementation

Due to COVID-19 pandemic and because of the safety rules imposed by the Cruces University Hospital (OSA) and Biocruces Bizkaia Health Research Institute (BCB), this Phase was postponed by a few weeks for the temporary impossibility of hosting face-to-face focus groups. However, since PD patients are older patients with cognitive decline and difficulties to speak by phone, we managed to perform the participatory design physically in a big meeting room and we divided the participants in two groups, in two different sessions and days. We had to assure a 2 meters distance between the participants, in order to respect the safety rules.

Once the enrolment process was over, end-user involvement in the evaluation of vCare was carried out according to the following 5 steps:

- *Step 1: First colloquial phone call*
  In a first colloquial phone call, with each potential participant, the general aim of the vCare project was clarified by the investigator and further details regarding the end-user involvement in the co-creation process of vCare service were presented.
- *Step 2: Video sharing*
  We met the participants in two different sessions and in two different days. We made a brief introduction of the general project, explaining all the phases of the project and

briefly introducing the videos. Afterwards, we watched the vCare storytelling video recorded by CCP in Italian with Spanish subtitles. Thereupon, we watched the vCare demo for PD patients recorded in Spanish including the specifications of PD and considering the symptoms of these patients.

- *Step 3: Interviews Instruction*

  After watching the videos, we asked the participants for their qualitative opinion and carried out brief interviews in order to collect their feedback.

- *Step 4: User Experience Questionnaire and open feedback*

  Besides registering their opinion, they also completed the **UEQ** questionnaire. The clinicians gave the participants support in the compilation of items only in case of difficulties, avoiding any bias action.

- *Step 5: In depth review analysis*

  All the UEQ scores and feedback were analysed in depth and the results are reported in section 3.3.

Participatory Design Methods in UMFCD

Enrolment of subjects

Due to the fact that we were not allowed to have patients in the hospital, we organised an online webinar on ZOOM on the 7th of September with free registration, with national coverage, to capture the general user experience and interest related to the innovative cardiac rehabilitation concept embedded in the vCare system.

There were 60 participants present during the online webinar.

Activities implementation

- *Step 1: General Introduction about disease burden*
  General presentation to the participants of the burden of heart failure in Europe and in Romania.

- *Step 2: General introduction on the role of cardiac rehabilitation*
  Presentation of the cardiac rehabilitation role in the life of a patient suffering with heart failure and description of the traditional cardiac rehabilitation processes.

- *Step 3: Video sharing*
  Presentation of the vCare concept movie for cardiovascular patients.

- *Step 4: Live interaction*
  Live interaction with the participants in order to make them better understand the system functionalities and to answer their questions.

- *Step 5: User Experience Questionnaire and open feedback*
  Application of the User Experience Questionnaire to the participants. 20 participants have responded to the online questionnaire.

- *Step 6: In depth review analysis*

All the UEQ scores and feedback were analysed in depth and the results are reported in section 3.3.

3.2.3. Phase 4: Full prototype

The next phase of the general Participatory Design process, Phase 4 – Full Prototype, will correspond to Task 1.5, Living Lab Phase. As planned in D1.5, during this phase, involved patients will be part of a double-stage evaluation:

1. **Field study**: patients will be enrolled to interact with the vCare system, while the clinical staff supervising the activities will evaluate, through the patient-system interaction, the system capabilities to adapt and personalize the clinical pathway solution to the patients' characteristics. Specific test cases will be foreseen to guide the evaluation process. Patients' feedback while using the system will be considered along the refinement process.
2. **Quantitative Usability Survey**: at the end of the Living Lab experience, each patient will be asked to answer to the System Usability Scale (SUS) questionnaire (see D1.5, Annex 7.6), in order to gather quantitative data about usability after experiencing the system. During the Tech Lab phase, the Participatory Design activities used the UEQ as a vehicle to gather general impressions on the system from patients; during the Living Lab phase instead, the administration of the SUS scale will bring the focus on a quantitative usability evaluation. Indeed, the SUS is one of the most popular methods in literature to evaluate user's perception of usability, thanks to its desirable psychometrics including high reliability and validity[6]. While the UEQ was administered after a demonstration video, the SUS will be given after the user will have had the opportunity to experience the system under investigation.

3.3 Results

The outcomes of the 4 stages of the Participatory Design during the Tech Lab are described henceforth.

3.3.1 Phase 2: Paper Prototyping and Application Sketching

CCP storytelling video

The CCP video is mainly based on First Narrative: Mrs. Maria – Use cases #1 and #2. The video shows a stroke patient in her interaction with the vCare system, in the context of an ordinary week. It is conceived to depict a storytelling about Mrs. Maria, just discharged from the hospital after a stroke event, and the impact that the vCare Virtual Coach, embodied in human appearance by the avatar, would have on her everyday life. It was decided to create a realistic character fully correspondent to a typical stroke patient, carrying fears, impairments and needs (just like it occurs in a large share of this kind of frail population) in order to allow each patient to actually figure him/herself in the different situations described. Through the

[6] Bangor, P. T. Kortum, and J. T. Miller, "An empirical evaluation of the system usability scale," *Int. J. Hum. Comput. Interact.*, vol. 24, no. 6, pp. 574–594, 2008.

narrator's voice, the spectator is able to follow Mrs. Maria in her interaction with the Virtual Coach along her first days back home, and is able to acknowledge the real benefits of such a system: continuity of care after discharge from the hospital, continuous home monitoring and detection of hazardous situations, physical and cognitive home rehabilitation. Nevertheless, it has to be considered that, in a realistic scenario, the benefits expected may be achieved only after a long-term period, whereas the video covers a time range of only one week.

The video has been produced in Italian language for CCP patients. An English subtitled version of CCP video is available at the following link:
https://wisecloud.wiwi.tu-dresden.de/s/wCNsSW1haIzfIQE

In addition, Spanish and Romanian subtitles have been created for this video to be used in these two clinical sites, in order to allow all patients to receive the same information from the same video and compare the questionnaire results.
Spanish subtitled version: https://wisecloud.wiwi.tu-dresden.de/s/Kj4hWaIYQIa68YR
Romanian subtitled version: https://wisecloud.wiwi.tu-dresden.de/s/AeHOBJ6dKgFBuX8

OSA storytelling video

For PD patients, in addition to the video produced by CCP, another video has been produced by OSA specifically for Parkinson's disease. The links of this video are the following:
Spanish version: https://wisecloud.wiwi.tu-dresden.de/s/F66SzMBhIgaPcvy

UMFCD storytelling video

UMFCD team has created a video material in Romanian and English in order to present the way a patient should engage with the rehabilitation system in a cardiovascular scenario. Romanian version: https://wisecloud.wiwi.tu-dresden.de/s/HtBPXDnIrCtgI9M
English version: https://wisecloud.wiwi.tu-dresden.de/s/2MTxqdaAo0NtWmn

3.3.2 Phase 3: Think aloud study and Qualitative Usability Survey

In all the clinical centres, the recruitment of subjects started at the end of June 2020 and interviews began in mid-July. Data collection and analysis ended in September 2020; a bit later (due to Covid-19 situation) compared to the end of task T1.4 (planned in M34).

Enrolment of subjects in CCP

CCP enrolled 10 subjects, 6 post stroke (5 Female,1 Male; age: 78.87 ± 9.81) and 4 healthy elderly (2 Male and 2 Female; age: 74.75 ± 7.89) from mid-July to early September.

Table 14 hereafter depicts the sample of enrolled subjects:

Table 14: Demographic and clinical characteristics of CCP enrolled subjects

Subjects	Year of birth (age)	Gender	Disease represented	Side affected
CCP_01	1933 (87)	F	Stroke	left
CCP_02	1939 (81)	F	Stroke	right

CCP_03	1937 (83)	F	Stroke	right
CCP_04	1952 (68)	F	Stroke	left
CCP_05	1931 (88)	F	Stroke	left
CCP_06	1955 (65)	M	Stroke	left
CCP_07	1949 (71)	M	Healthy Elderly	/
CCP_08	1954 (66)	F	Healthy Elderly	/
CCP_09	1942 (78)	M	Healthy Elderly	/
CCP_10	1936 (84)	F	Healthy Elderly	/

Enrolment of subjects in OSA

OSA enrolled 13 subjects, 7 PD patients (6 Males, age: 61.83 ± 8.01; 1 Female, 67 years) and 6 healthy controls (6 Females, age: 52.50 ± 8.41) in September.

Table 15 *hereafter depicts the sample of enrolled subjects.*

Table 15: Demographic and clinical characteristics of OSA enrolled subjects

Subjects	Age	Gender	Disease represented
OSA_01	64	M	PD
OSA_02	74	M	PD
OSA_03	67	F	PD
OSA_04	65	M	PD
OSA_05	60	M	PD
OSA_06	50	M	PD
OSA_07	58	M	PD
OSA_08	41	F	Healthy control
OSA_09	50	F	Healthy control
OSA_10	60	F	Healthy control
OSA_11	61	F	Healthy control
OSA_12	58	F	Healthy control
OSA_13	45	F	Healthy control

Enrolment of subjects in UMFCD

The data about the online webinar participants were collected via their registration on the related Facebook event. There were 60 participants, 20 of which completed the UEQ, aged 62.4 ± 7.26 years, 11 Women and 9 Men, with interests covering heart failure rehabilitation and rehabilitation in ischemic heart disease.

Table 16: Demographic and clinical characteristics of UMFCD enrolled subjects

Subjects	Age	Gender	Disease represented
UMFCD_01	65	F	Heart failure
UMFCD_02	65	F	Heart failure
UMFCD_03	64	F	Ischemic heart disease

UMFCD_04	68	F	Ischemic heart disease
UMFCD_05	53	F	Heart failure
UMFCD_06	65	M	Heart failure
UMFCD_07	49	M	Heart failure
UMFCD_08	66	F	Heart failure
UMFCD_09	54	M	Healthy Elderly
UMFCD_10	69	F	Heart failure
UMFCD_11	70	F	Ischemic heart disease
UMFCD_12	67	F	Ischemic heart disease
UMFCD_13	69	M	Heart failure
UMFCD_14	55	M	Heart failure
UMFCD_15	47	F	Healthy Elderly
UMFCD_16	66	M	Ischemic heart disease
UMFCD_17	67	F	Heart failure
UMFCD_18	55	M	Heart failure
UMFCD_19	65	M	Healthy Elderly
UMFCD_20	69	M	Heart failure

UEQ questionnaire results in CCP, OSA, and UMFCD

Results were analysed after transforming the score for each item: the +3 represents the most positive and the -3 the most negative value. Values between -0.8 and 0.8 represent a more or less neutral evaluation of the corresponding scale, values > 0,8 represent a positive evaluation and values < -0,8 represent a negative evaluation.

The results from the three clinical centres are presented together henceforth. Data were first checked to detect inconsistencies among answers. Since all items in a domain should measure a similar User Experience quality aspect, it was checked how much the best and worst evaluation of an item in a domain differed. No inconsistency was found among data.

The comparison among the three clinical centres in terms of mean and standard error across all subjects for each domain are presented in the bar plot in Figure 6. To notice that the mean value of the distributions is always in the upper part of the diagram (positive evaluation).

A One-Way ANalysis Of VAriance (ANOVA) was carried out to check if the domain means differ significantly among the three clinical centres. The Alpha-Level 0.05 was used. The results are reported in the tables below. A statistically significant difference between groups was found only in the Efficiency domain.

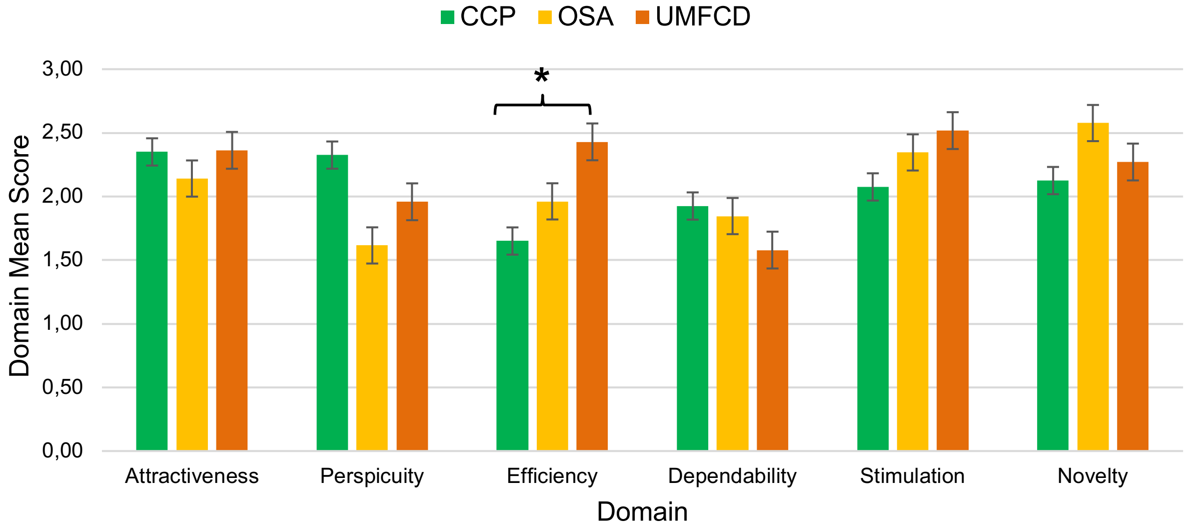

Figure 6: Comparison among the mean values for each domain for the three clinical centres

Table 17: Results of One-way ANOVA

Attractiveness	Summary						
	Groups	*Counts*	*Sum*	*Mean*	*Variance*		
	CCP	10	23,50	2,35	0,21		
	OSA	13	27,83	2,14	0,24		
	UMFCD	20	47,25	2,36	1,40		
	ANalysis Of VAriance						
	Sources	*SS*	*df*	*MS*	*F*	*p-value*	*F crit*
	Between Groups	0,43	2	0,21	0,27	0,76	3,23
	Within Groups	31,31	40	0,78			
	Total	31,74	42				
Perspicuity	Summary						
	Groups	*Counts*	*Sum*	*Mean*	*Variance*		
	CCP	10	23,25	2,32	0,54		
	OSA	13	21,00	1,62	1,24		
	UMFCD	20	39,17	1,96	1,09		
	ANalysis Of VAriance						
	Sources	*SS*	*df*	*MS*	*F*	*p-value*	*F crit*
	Between Groups	2,86	2	1,43	1,41	0,26	3,23
	Within Groups	40,47	40	1,01			
	Total	43,32	42				
Efficiency	Summary						
	Groups	*Counts*	*Sum*	*Mean*	*Variance*		
	CCP	10	16,50	1,65	0,77		
	OSA	13	25,50	1,96	0,53		
	UMFCD	20	48,58	2,43	0,62		

	ANalysis Of VAriance						
	Sources	*SS*	*df*	*MS*	*F*	*p-value*	*F crit*
	Between Groups	4,44	2	2,22	3,55	**0,038**	3,23
	Within Groups	25,04	40	0,63			
	Total	29,48	42				
Dependability	Summary						
	Groups	*Counts*	*Sum*	*Mean*	*Variance*		
	CCP	10	19,25	1,93	0,28		
	OSA	13	24,00	1,85	0,62		
	UMFCD	19	30,00	1,58	1,99		
	ANalysis Of VAriance						
	Sources	*SS*	*df*	*MS*	*F*	*p-value*	*F crit*
	Between Groups	0,98	2	0,49	0,42	0,66	3,24
	Within Groups	45,83	39	1,18			
	Total	46,81	41				
Stimulation	Summary						
	Groups	*Counts*	*Sum*	*Mean*	*Variance*		
	CCP	10	20,75	2,08	0,56		
	OSA	13	30,50	2,35	0,20		
	UMFCD	19	47,83	2,52	0,92		
	ANalysis Of VAriance						
	Sources	*SS*	*df*	*MS*	*F*	*p-value*	*F crit*
	Between Groups	1,29	2	0,64	1,04	0,36	3,24
	Within Groups	24,10	39	0,62			
	Total	25,38	41				
Novelty	Summary						
	Groups	*Counts*	*Sum*	*Mean*	*Variance*		
	CCP	10	21,25	2,13	0,73		
	OSA	13	33,50	2,58	0,15		
	UMFCD	20	45,42	2,27	0,96		
	ANalysis Of VAriance						
	Sources	*SS*	*df*	*MS*	*F*	*p-value*	*F crit*
	Between Groups	1,28	2	0,64	0,97	0,39	3,23
	Within Groups	26,49	40	0,66			
	Total	27,78	42				

*SS= Sum of Squares, df= degrees of freedom, MS= Mean of Squares, F= F-value

Qualitative semi-structured interviews results

The qualitative survey intended to directly collect end-users' needs, expectations, fears and any kind of feedback regarding the usability and liking of the solution implemented by Technical Partners and supervised by Clinical Partners in the lab tests.

The basic tenets that have led the investigator along the interview's pathway could be summarized as:

- Evaluation of technological affinity with devices
- Evaluation of intrusiveness brought by sensors
- Evaluation of the caregiver burden
- Evaluation of the vCare activities
- Evaluation of the Virtual Coach as an ongoing service

Each of these criteria was linked to one or more scenes of the demonstration video and/or to items mentioned in the UEQ, and was discussed by the interviewer, in order to collect practical and relevant considerations for the Technical Partners to implement future adjustments for the Living Lab preparation.

A summary of the collected information is presented hereafter.

<u>Evaluation of technological affinity with devices</u>

Most interviewed end-users do not consider technology as a wall that's too hard to climb, as long as they are properly instructed and trained to its usage by skilled personnel. Still, some of them expressed concerns about a "too intensive" interaction, for instance when having to type on a keyboard or when dealing with software accessibility (e.g., in the case of too many buttons to click or complex processes to manage). Almost everyone agreed to consider voice control and avatar conversation through a pad as a viable mode of interaction, although someone has suggested to keep sentences rather short during conversational events. In other words, short and direct feedback seems to be more appreciate. Finally, regarding the remote monitoring by the physician, it was found that patients prefer a more immediate and direct voice- or video-chat with their physician, especially when the user needs to have urgent consultation with his/her healthcare professional. An 88-years-old stroke patient said "*I am user-friendly with tech*".

<u>Evaluation of intrusiveness brought by sensors</u>

Regarding the level of intrusiveness perceived by the respondents, the result seems to be very positive for almost all subjects. The collection of indoor and wearable sensors showcased in the video or explained directly by the investigator was widely accepted by end-users, because in the back end of the entire sensors kit, they recognized their healthcare provider or even, more in depth, their personal healthcare professional (physician, physiotherapist…). This implies the need, for the healthcare provider/professional, to monitor these kinds of dashboards with a certain frequency, also to avoid false positive alerts. The level of identification and trust in the Healthcare assistance was so high that a 68-years-old female stroke patient said: "*I would not feel uncomfortable talking with a pad or with a virtual coach; on the other hand, after becoming familiar with it, the conversation would be as natural as with my doctor*". It is interesting to observe how only the most autonomous stroke patients (i.e. the ones with minor motor impairments and minor need of constant help from their caregivers)

reported to slightly dislike the Virtual Coaching “Big Brother” eyes, in contrast with all the healthy elderly population interviewed that considered a valuable feature the remote monitoring for inactivity tracking, detection of potential unsafe behaviours and so on. A 66-years-old healthy elderly said “*I have nothing to hide*”.
However, some PD patients reported doubts about possible lack of privacy. In addition, a PD patient said that using this system could make him more aware of the disease and his symptoms and this could be negative for him because he would have it on his mind all the time.

Evaluation of the caregiver burden

Undoubtedly, vCare project is designed to manage moderate, not severe clinical conditions. The role and importance of a real caregiver role cannot be replaced by a Virtual Coach; however, reducing the burden of caregivers is a valuable area to explore. Acceptance, trust, activity and behaviour remote monitoring, socialization and assistance cost savings were the most attractive aspects for the interviewed subjects. Almost all of them reported a positive consideration regarding this topic. Their relatives and unofficial caregivers would seem glad to adopt the vCare solution; The most relevant motivations are: *“it is a supportive healthcare service”*, *“it is a safe platform to deal with my impairments”* and *“it is less expensive than a professional caregiver”*. Many respondents declared that their families would be pleased to receive remote alerts concerning daily behaviours and reports about activities progress. Finally, it’s worth mentioning an 88-years-old person who expected a lack of empathy from an in-screen avatar, compared to a real caregiver, especially if established in the family’s entourage since many years.

Evaluation of the vCare activities

Although untested by specific questions, some insights were explored regarding some of the Clinical Activities, as documented in D1.4 – Annex 6.6:

- *Home-based motor activities:* the motor serious games appear to be widely approved by respondents, thanks to their physical activity engagement, notwithstanding some doubts emerged about potential limits in terms of physical safety and balance issues. The latter could be addressed by offering the option of physical Serious Games sessions in a safe, easily accessible sitting position.
- *Indoor monitoring:* the environmental monitoring and the related features were judged as a “continuous monitoring” capable to “correct what’s wrong” in the behavioural habits, even if some “stealthy” functionalities as time of inactivity detection and walking aid adherence seemed unexpected to the respondents.
- *Home based cognitive activities:* the cognitive stimulations were appreciated as well, by the interviewees, although they couldn’t clearly identify the psychological capabilities being enhanced.
- *E-learning:* no specific quotations mentioned this service and no objections occurred about providing lessons and drills via pad.
- *Vital stats monitoring:* no specific quotations mentioned this service and no objections occurred related to the frequency of interaction needed.

- *Mood monitoring:* undoubtedly, the psychological support and in general the motivational reinforcement revealed a trending topic across the interviewees' needs. The development and endorsement process are believed to be still lacking of positive stimuli and consequently engagement could be insufficient in some patients who reported recurrent deflection of their mood. As potential improvements, an enhancement of motivational feedback according to the psychological status of the patient along daily activities could be taken into consideration and should be fine-tuned, with the help of neuropsychologists.

<u>Evaluation of the Virtual Coach as an ongoing service</u>

This last parameter of assessment concerned benefits and limits reported by the subjects in an overall perspective of the proposed solution and contextualized in a long-term deployment process, provided by the healthcare system. Within the most appreciated perks, the following features emerged: the multiple clinical context (4 different diseases considered), the integrated quality of life perspective (multiple healthcare professionals' skills), and the different rehabilitation approaches, provided 7 days a week at their own home without excluding in-hospital examinations.

3.4 Discussions and Conclusions

Participatory Design activities during this phase (Tech Lab Phase) were also meant to engage end-users to participate actively in the Virtual Coaching design process (co-design process) at later stages, in order to evaluate how users' impressions change when moving to a direct experience of the system. To this end, a suggestion could be to propose again the UEQ and the same semi-structured interview at the end of the Living Lab, along with SUS evaluation, as mean of comparison. In addition, in order to maximize the methods to gather feedback also from a wider set of stakeholders, including also decision makers from public health bodies, Participatory Design activities in the next phase could foresee the organization of workshops and/or the administration of evaluation questionnaires.

In this very first step of the whole Participatory Design process, the project consortium collected preliminary remarks to guide the system refinement process to fulfil its long-term goal: to guarantee a final release fully consistent with end-users' expectations. This document can therefore be considered an initial knowledge background for co-creation of the solution fine tuning, to be further enhanced during the following phase (Living Lab Phase), where patients will have the opportunity to directly interact with the system.

From the UEQ scores and open feedback results, gathered after watching the video storytelling, interesting remarks can be extrapolated to plan and continue the refinement process of the solution according to user preferences.

From the User Experience Questionnaire survey, on average, the scores resulted >1.5 in all the six domains (attractiveness, perspicuity, efficiency, dependability, stimulation, novelty), giving an overall very positive perception of the service. This result gives a hint that subjects affected by either neurological or cardiological disease, would appreciate the solution. In particular, it is noticeable that the most positive evaluations resulted for the Attractiveness, Stimulation, and Novelty domains. Being these domains related to user-friendliness, user interest, and innovation of the service, this could be a sign that the vCare solution could interest the subjects for its originality and peculiarities. From the ANOVA analysis, only in the Efficiency domain a statistically significant difference was found between groups. This last result may be explained by the difficulty in evaluating the items related to this domain (fast/slow; inefficient/efficient; impractical/practical; organized/cluttered) from the presentation of the solution by a video storytelling, without direct use of the system. Therefore, all the items related to the Efficiency domain may have been understood differently by the groups.

Important remarks were extrapolated by the open feedback coming from the semi-structured interview. Some **attention points** can be highlighted and taken into consideration to guide system refinement.

Efficiency and Perspicuity domains (see Annex 9.2) results can be related to the open feedback regarding the *evaluation of technological affinity with devices*. Subjects enrolled by the three clinical centres rated these items with an overall positive evaluation consistently with their feedback on their ability to use technological solutions, but the majority of them underlined the importance of an interaction with such systems through an easy-to-use interface. Indeed, subjects affirmed to be more likely to use a system with a very easy interface (voice control and avatar are seen as positive, while keyboard or “too many buttons” as negative). This aspect should be taken into consideration, also working in collaboration with neuropsychologists, to make the User Experience in using the system as simple as possible. Summarizing, a technological interface for the elderly, even with mild impairments, doesn’t seem to be a social taboo for a promising deployment of digital healthcare services, but it needs to be easy to access, prompt and natural in the ways of interacting, for instance through the human-like avatar.

Dependability domain (see Annex 9.1) results can be related to the open feedback regarding the *evaluation of intrusiveness brought by sensors*. On average, the results of such items were rated with positive evaluations by the enrolled subjects, with the exception of few subjects (the most independent and autonomous) that slightly dislike the Virtual Coaching “Big Brother” eyes. Perception of intrusiveness changes if the monitoring is accompanied by the remote advice. In this perspective, specific monitoring interfaces for the healthcare professionals are crucial.

Efficiency, Dependability, and Novelty domains (see Annex 9.1) results can be related to the open feedback on the *evaluation of caregiver burden*. The positive results coming from these domains are consistent with the positive evaluation in terms of perceived support given to caregivers to monitor patients’ behaviour remotely. In this area of interest, subjects remarked the importance of providing proper alerts on the “wrong” behaviours. Some concern arose only in terms of the comparison of empathy that can be expressed by a Virtual Coach, compared to a human caregiver. To overcome this concern, the human-like behaviour and appearance of the avatar should be as well-finished as possible.

Interesting results came from the open feedback regarding the *evaluation of the vCare activities,* since this evaluation can be linked to a global evaluation of what such a system can offer to patients, with particular connection to Attractiveness and Stimulation domains (see Annex 9.1). As testified by the open feedback, patients appreciated the potentialities of the service judging it pleasing, interesting, and motivating. With particular reference to motivation, patients remarked the importance of the “psychological” dimension of a Virtual Coach.

Subjects advised to let the Virtual Coach provide different and personalized typologies of positive stimuli to motivate the patients with recurrent mood deflection.

Finally, from a global assessment of all six questionnaire domains, it is noticeable that, on average, subjects seemed enthusiastic about the overall proposed solution which emerged from the feedback about the *evaluation of a Virtual Coach as a running service, provided by the healthcare system*. Patients seemed to appreciate the system especially for the possibility to expand the educational process from the clinic to their home, guaranteeing continuity of care.

To conclude, Participatory Design activities during Tech Labs Phase allowed to gather significant feedback to be conveyed to Technical Partners, for them to enhance the user-friendliness and attractiveness of the solution following end-users direct input. The study was also meant to support the information/motivation of the patients to participate in the later stages of the testing process and later on to measure the distance between projection and direct experience in the Living Labs. Up to now, from the overall evaluation, positive results emerged on the evaluation of this kind of service, especially regarding the attractiveness, novelty, and stimulation of the vCare solution, giving a hint that such a system can change and strongly innovate home-rehabilitation.

4. SHOWCASES

The internal reviews of the vCare TechLabs sprints defined the measure of how the vCare functionalities were fulfilled and how efficient was our integrated tests (following the iterative procedure as defined in chapter 5). These reviews were organized using GoToMeeting teleconference system and all the technical partners and the product owner participated. In these meetings the technical partners presented showcases or demos of their applications to check if the acceptance criteria, in form of the functional and non-functional requirements, were respected.

One of the core objectives of the demos was to review progress against the sprint goal and team commitment. It was an opportunity to get everyone on the same page in terms of what was accomplished, what is still in progress and what changes were made.

It has to be noted that not all showcased components are reflected in the test cases as defined in D1.5 and realized in the current document (see chapter 7). The architectural/technical aim to be reached at the end of the TechLab is quoted again below (taken from D7.4). For example, the pathway modeler would only need to be ready for manual adaptions of the clinical pathways. Also, it is not part of the test cases as the patient as the final user of the vCare solution is not directly confronted with the clinical pathways. However, these build the procedural basis for the rehabilitation care. The pathway layer provides the pathway information to the Professional Portal (allowing the choice and instantiation of the pathway template to a patient-specific one) and the Knowledge layer (e.g., allowing the derivation of patient's schedule). Thus, it still is an important component of the overall solution. Its functioning shall be known by all partners. This argument would also be valid in a similar way for other components. Therefore, a broad set of demo cases has been conducted to provide the technicians a broad overview of the technical developments taking place.

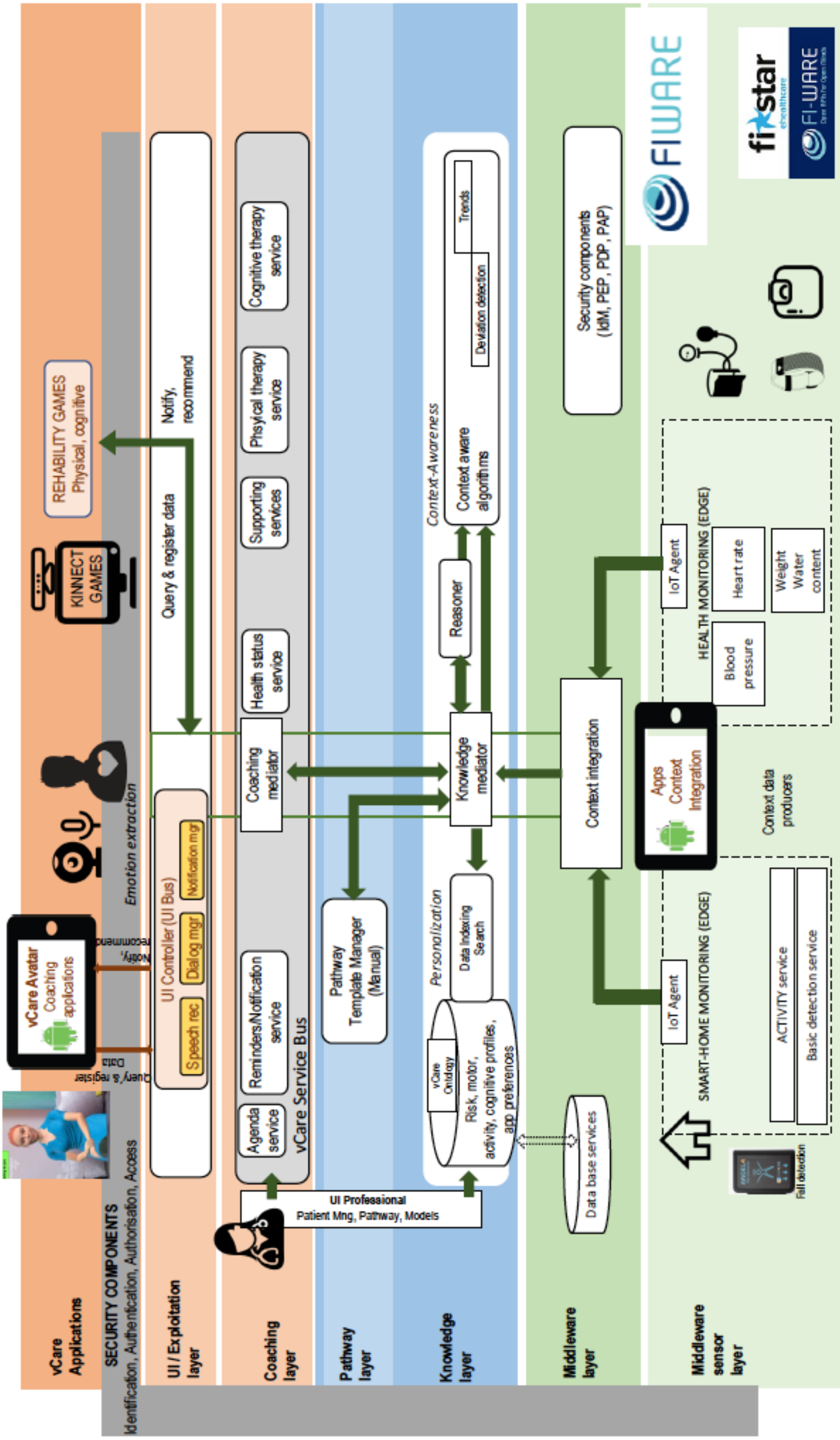

Figure 7: vCare architecture at the end of Tech-Labs phase

In the following sections are described some showcases the technical partners held during the review sprint meetings.

4.1 Clinical Pathway Modeller Showcase

The primary aim is to fulfil a technical use case in terms of the pathway management (addressing requirements R6-1-1 and R6-2-1). The development is part of the services of the overall vCare solution's pathway layer providing the capability to graphically model and adapt rehabilitation care pathway templates. The functions will be initially tested and iteratively refined during the project's lab test phases. More details can be found in D6.2. According to D6.1 we perceive BPMN (plus the extension as needed for vCare project's rehabilitation case) as most promising graphical conceptual modelling language for clinical pathways (CPs) for vCare's purposes in comparison to the alternative approaches.

Figure 8 shows the creation of an exemplary template[7]. The elements available for modelling (representing the desired or possible rehabilitation procedure from the clinical point of view) can be chosen on the left side. It is also possible to alter already placed nodes or to further link elements. The templates can be stored and exported. Also, the properties of single pathway template elements can be altered directly in the modeler.

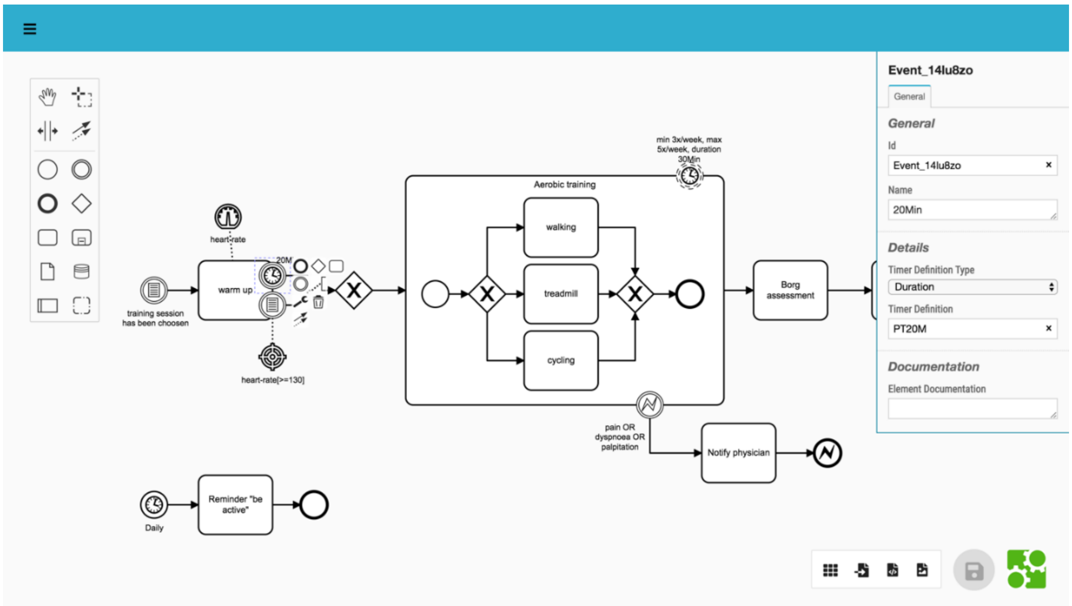

Figure 8: Screenshot of the vCare-Modeler showing the creation of an exemplary and simplified rehabilitation care pathway template for a cardiological case

[7] Please note that the application as shown is firstly only used for test purposes to be able to solely use the pathway modelling and template management. The application is to be integrated into AIT's professional portal (WP3). Also, the full link and transferability of the pathway information both to the professional portal and the knowledge layer (see D6.3 and D6.4) is not reflected in this single-component showcase.

Further on, the “Template Gallery” is to overview the available rehabilitation care pathway templates. Here, a graphical overview/snippet, plus the name, ID and short description are shown to allow the physician to easily overview or choose the most appropriate template.

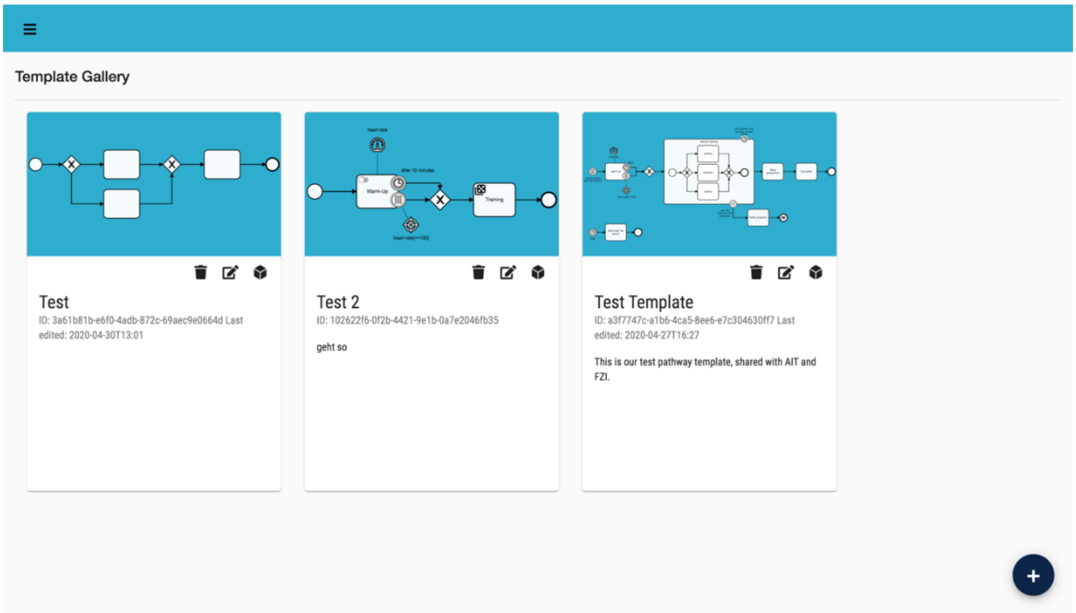

Figure 9: Screenshot of the Template Gallery of the vCare-Modeler showing available exemplary rehabilitation care pathway templates

Figure 10 shows the HAPI FHIR[8] server’s interface for accessing the details of the PlanDefinition resource that is the technical representation of the graphically modelled rehabilitation care pathway template. Here, options how to encode or summarise the resource can be set or the processing/response details of the server or results of queries can be displayed.

[8] See: https://hapifhir.io

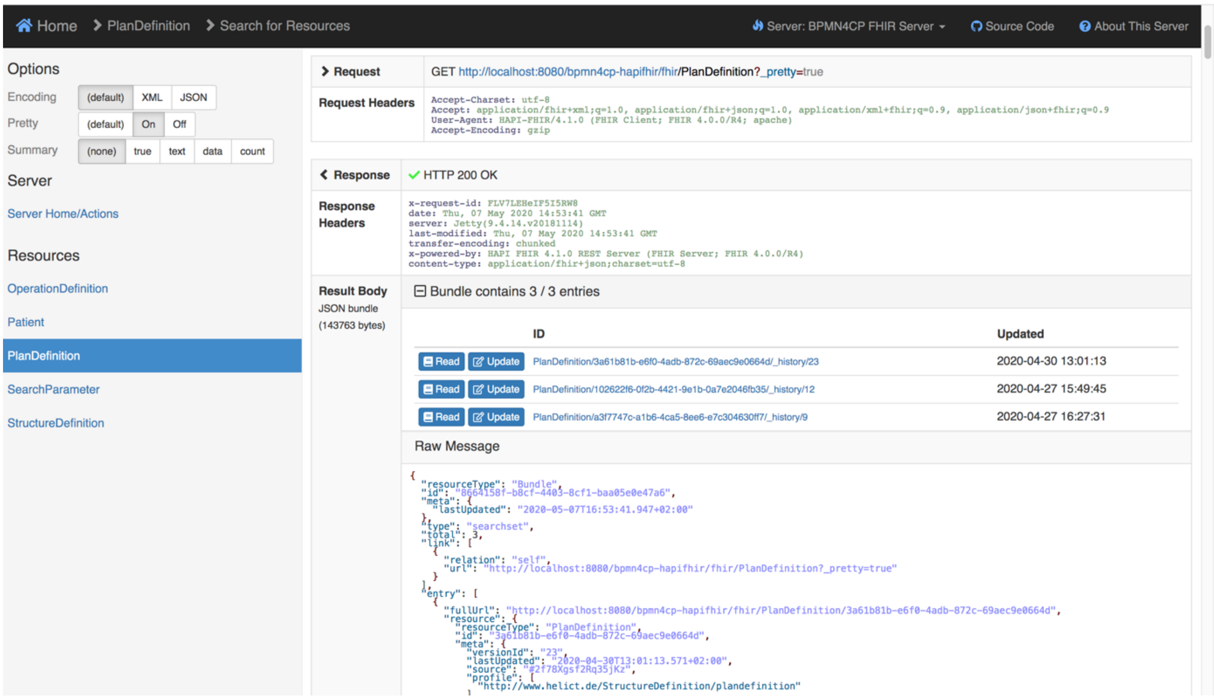

Figure 10: Screenshot showing the HAPI FHIR server's interface accessing the PlanDefinition details

4.2 VITAL SIGNS AND ACTIVITY MONITORING SHOWCASE

This showcase aims to collect data from patient's medical devices and activity tracker and send to MQTT broker in order to feed further the knowledge layer and the virtual coach. These activities are part of the requirements R7-1 Vital signs monitoring, R7-2 Fitbit, outdoors and indoors physical activity monitoring and R7-3 Blood pressure monitoring, as they are derived from the cardiology use-cases. The medical devices are connected using Bluetooth to the Telemonitoring application, installed on an Android tablet, which acts as a gateway to the vCare middleware.

After the patient was subscribed in the system, the main menu of the application is unlocked[9] (Figure 8). The main menu is composed of the following functions:

- **Measurements:** Shows the Measurements screen where all the data is aggregated.
- **Sensors:** Shows the connected devices screen. In this window the user can add new devices or remove the existing ones. Also, from here the user can access their respective measurement screens.

[9] Please note that the application as shown is only used for test purposes to be able to solely test the vital sign and activity monitoring. The application will not be part of the final vCare solution as the measurements are directly transferred from the sensor layer via the middleware to the upper layer consuming and further processing these data (see again Figure 7 where the context integration is outlined). Finally, the avatar as the single point of contact for the patient might present the (aggregated/processed) data to the patient or this is used as a basis for rehabilitation coaching recommendations.

- **Statistics:** Shows the data captured from the last measurements
- **Advices:** Opens the window where the user can see notifications sent from the virtual coach or the medical staff.

A primary test function of the Android application is to discover and register the Bluetooth devices used for measurements. In Figure 12 is displayed the screenshot of the window with devices connected to the tablet. Unused connected devices can also be removed from the application using the same screen. After a device is registered in the application, it is ready to send data measured.

The blood pressure device, after connection and registration in the Android test application, is attached to the patient's arm. The patient turned on the medical device, the scuff was inflated and the measurements of the systolic and diastolic blood pressure are displayed on the blood pressure device screen, as well as on the Telemonitoring test application (Figure 13). The mobile application is connected to the MQTT broker so that every new measurement is sent instantly to the queue.

If the user wants to see the last measurements from all the devices connected, he/she can access the Statistics menu and the window of all last measurements is displayed (Figure 14)

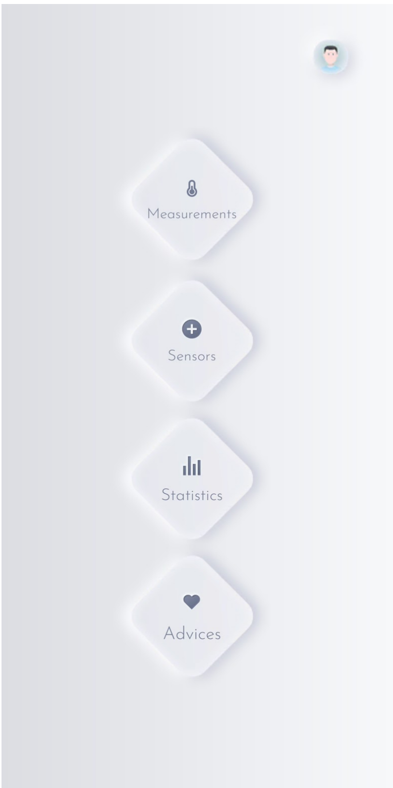

Figure 11: Telemonitoring app – Main menu (UI used only for test purposes)

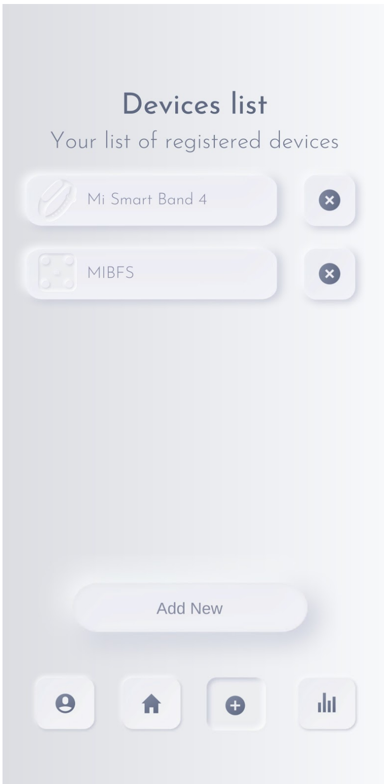

Figure 12: registered devices (UI used only for test purposes)

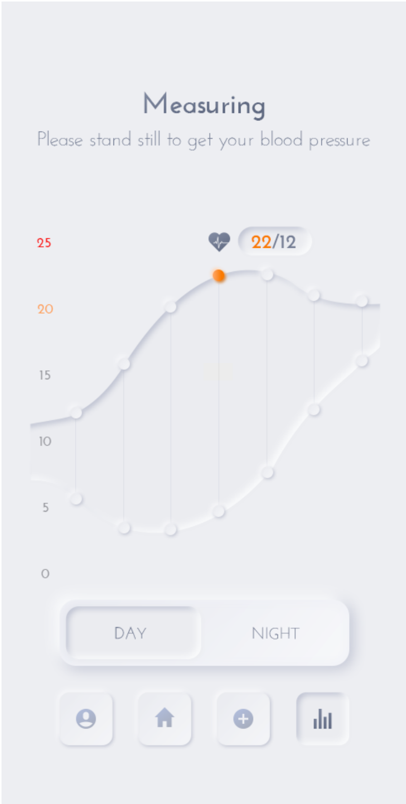

Figure 13: Blood pressure measurements (UI used only for test purposes)

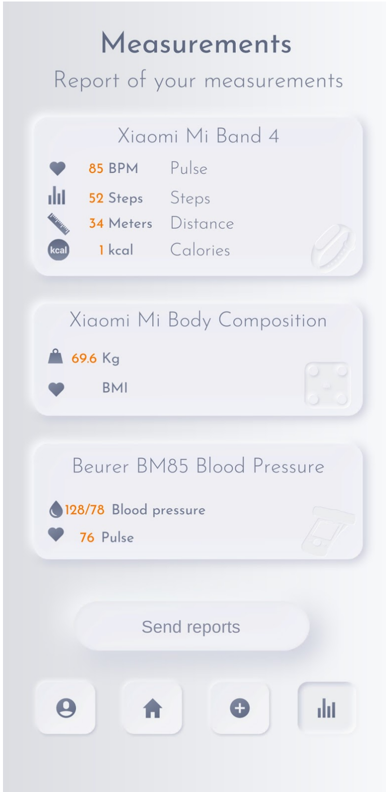

Figure 14: Last measurements (UI used only for test purposes)

4.3 PATIENT FRONTEND AND SERVICES SHOWCASE

This showcase aims at demonstrating and testing the equipment and services interacting with the patient at his home environment. This includes the Rehability System running an Android Set top box with the 3D depth camera connected to a TV and the tablet with the vCare UI (Figure 15).

On the UI, the user can interact with the system via speech input and via the buttons on the touch screen. Some examples are given below showing the agenda (Figure 16), the current activities overview (Figure 17), the e-learning screen (Figure 18) and a notification (Figure 19). The main aim is to test the interaction with the system as preparation for the Living Lab phase starting directly after the TechLab phase. In general, the demonstration provides the first prototype of the overall system implementing the messages flows realizing the test cases of this document.

Figure 15: vCare home rehabilitation setup (set top box left of the TV, tablet right of the TV, depth camera on the top of the TV)

Figure 16: Screenshot showing the vCare rehability agenda (SS2)

Figure 17: Screenshot of the vCare app showing the current activity overview (CS2)

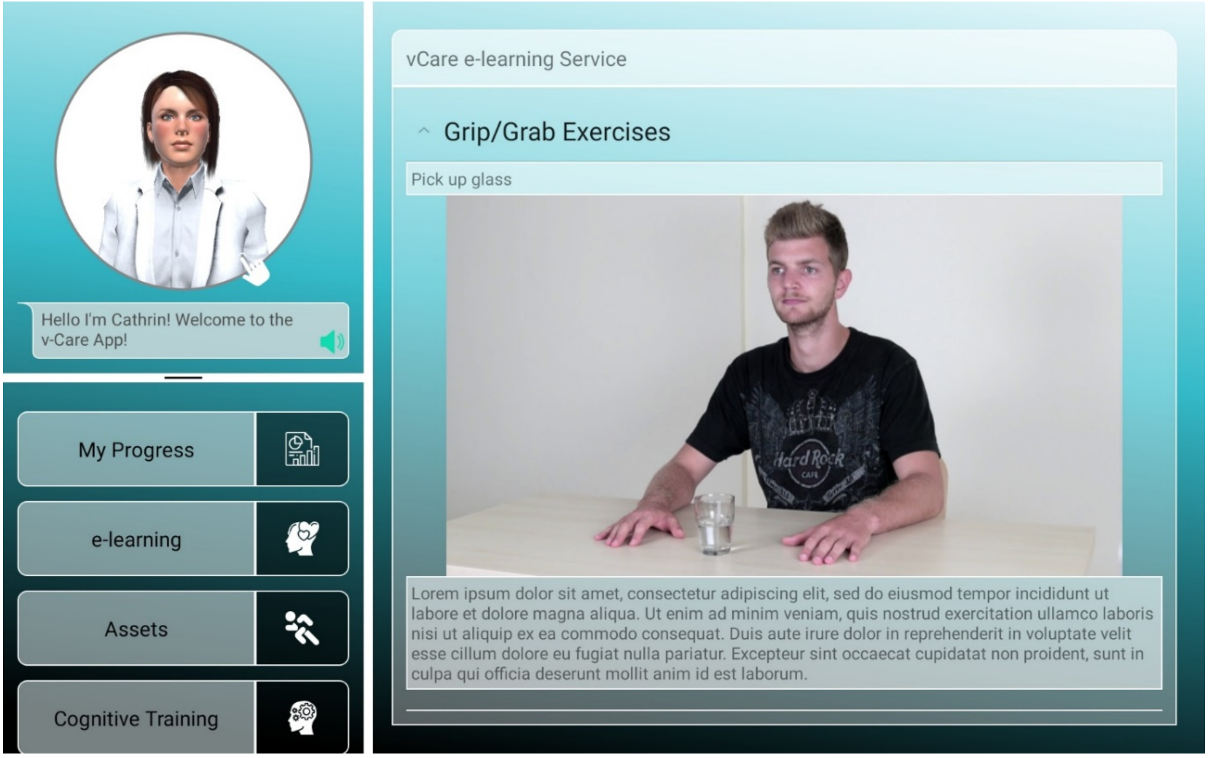

Figure 18: Screenshot of the vCare app showing e-learning content (CS4)

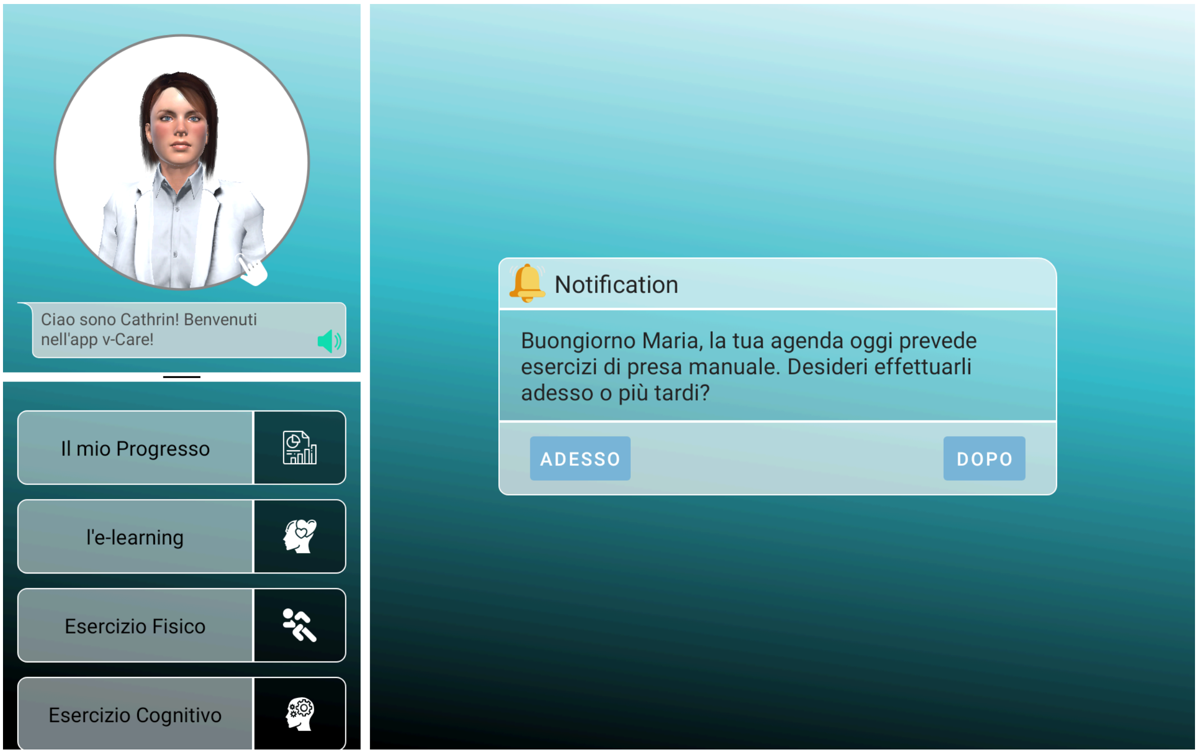

Figure 19: Screenshot of the vCare UI showing a notification in Italian (CS6)

At the AIT Tech Lab, in addition to the home environment equipment, also the coaching services layer and the caregiver system (KIOLA) are running in dedicated virtual servers. All layers are connected via the MQTT message protocol controlled by the MQTT broker. As described in detail in D5.3, the coaching services layer runs within an Apache Karaf container to ensure modularity and flexibility. Figure 20 shows the console of the Apache Karaf container listing the installed which includes the current version of all coaching and supporting services and a number of additional bundles which contain helper modules and commonly used classes such as data models or utils among others.

vCare-Server

```
  vCare Server 0.0.3-SNAPSHOT
  (running on Apache Karaf 4.2.9)

Hit '<tab>' for a list of available commands
and '[cmd] --help' for help on a specific command.
Hit 'system:shutdown' to shutdown.
Hit '<ctrl-d>' or type 'logout' to disconnect shell from current session.

Loaded vCare extension script
vcare@root()> list
START LEVEL 100 , List Threshold: 50
 ID | State    | Lvl | Version             | Name
----+----------+-----+---------------------+----------------------------------------------------
 26 | Active   |  80 | 3.10.0.1            | Common - Liquibase - Pax-JDBC Support
 28 | Active   |  80 | 1.0.10              | Common - Utils
 29 | Active   |  80 | 1.0.2.SNAPSHOT      | Dialog-Manager - Common
 30 | Active   |  80 | 1.0.2.SNAPSHOT      | Dialog-Manager - Common Shell
 31 | Active   |  80 | 2.8.5               | Gson
 32 | Active   |  80 | 29.0.0.jre          | Guava: Google Core Libraries for Java
 33 | Active   |  80 | 1.0.1               | Guava InternalFutureFailureAccess and InternalFutures
 36 | Active   |  80 | 20200518.0.0        | JSON in Java
 38 | Active   |  80 | 4.4.0               | Apache Commons Collections
 39 | Active   |  80 | 2.7.0               | Apache Commons IO
 40 | Active   |  80 | 3.10.0              | Apache Commons Lang
 41 | Active   |  80 | 3.6.0               | Apache Commons Net
 48 | Active   |  80 | 4.2.9               | Apache Karaf :: OSGi Services :: Event
 56 | Active   |  80 | 1.9.3.1             | Apache ServiceMix :: Bundles :: jasypt
 58 | Active   |  80 | 4.17.0              | Apache XBean OSGI Bundle Utilities
 59 | Active   |  80 | 4.17.0              | Apache XBean :: Classpath Resource Finder
 80 | Active   |  80 | 1.3.72              | kotlin-osgi-bundle
 81 | Active   |  80 | 1.4.0               | JGraphT - Core
 82 | Active   |  80 | 0.14.0              | JHeaps
 88 | Active   |  80 | 1.4.4               | OPS4J Pax JDBC Generic Driver Extender
 89 | Active   |  80 | 1.4.4               | OPS4J Pax JDBC Config
 90 | Active   |  80 | 1.4.4               | OPS4J Pax JDBC Pooling Support Base
 95 | Active   |  80 | 1.0.0.201505202023  | org.osgi:org.osgi.service.jdbc
 97 | Active   |  80 | 1.0.2               | DAPAS - Flurry - Common
 98 | Active   |  80 | 1.0.2               | DAPAS - Flurry - Persistence
 99 | Active   |  80 | 1.0.0               | DAPAS - LimeSurvey - Common
100 | Active   |  80 | 1.0.0               | DAPAS - LimeSurvey - Persistence
101 | Active   |  80 | 1.0.2.SNAPSHOT      | Dialog-Manager - Common MQTT
102 | Active   |  80 | 1.0.2.SNAPSHOT      | Dialog-Manager - Server - Connector - Keycloak
103 | Active   |  80 | 1.0.2.SNAPSHOT      | Dialog-Manager - Server - DialogFlow - Core
104 | Active   |  80 | 1.0.2.SNAPSHOT      | Dialog-Manager - Server - DialogFlow - Core - Extender
105 | Active   |  80 | 1.0.2.SNAPSHOT      | Dialog-Manager - Server - DialogFlow - Core - Shell
106 | Active   |  80 | 1.0.2.SNAPSHOT      | Dialog-Manager - Server - Event - Connector - MQTT
107 | Active   |  80 | 1.0.2.SNAPSHOT      | Dialog-Manager - Server - Services - DialogFlow - Agenda
108 | Active   |  80 | 1.0.2.SNAPSHOT      | Dialog-Manager - Server - Services - DialogFlow - Joke
109 | Active   |  80 | 1.0.2.SNAPSHOT      | Dialog-Manager - Server - Services - DialogFlow - News
110 | Active   |  80 | 1.0.2.SNAPSHOT      | Dialog-Manager - Server - Services - DialogFlow - Numbers
111 | Active   |  80 | 1.0.2.SNAPSHOT      | Dialog-Manager - Server - Services - DialogFlow - Questionnaire
112 | Active   |  80 | 1.0.2.SNAPSHOT      | Dialog-Manager - Server - Services - DialogFlow - Standby
113 | Active   |  80 | 1.0.2.SNAPSHOT      | Dialog-Manager - Server - Services - DialogFlow - Weather
114 | Active   |  80 | 1.0.2.SNAPSHOT      | Dialog-Manager - Server - Services - Manager
115 | Active   |  80 | 1.0.2.SNAPSHOT      | Dialog-Manager - Server - Shell - Event Connector
116 | Active   |  80 | 0.0.3.SNAPSHOT      | vCare - Common
117 | Resolved |  80 | 0.0.3.SNAPSHOT      | vCare - Server - Branding - WebConsole, Hosts: 53
118 | Active   |  80 | 0.0.3.SNAPSHOT      | vCare - Server - Branding - WebConsole Plugin
119 | Active   |  80 | 0.0.3.SNAPSHOT      | vCare - Server - Endpoints - Landing
120 | Active   |  80 | 0.0.3.SNAPSHOT      | vCare - Server - Services - DialogFlow - CS1 (Physical Training)
121 | Active   |  80 | 0.0.3.SNAPSHOT      | vCare - Server - Services - DialogFlow - CS2 (Health)
122 | Active   |  80 | 0.0.3.SNAPSHOT      | vCare - Server - Services - DialogFlow - CS3 (Cognitive Training)
123 | Active   |  80 | 0.0.3.SNAPSHOT      | vCare - Server - Services - DialogFlow - CS4 (e-Learning)
124 | Active   |  80 | 0.0.3.SNAPSHOT      | vCare - Server - Services - DialogFlow - CS6 (Notification/Scheduler)
125 | Active   |  80 | 0.0.3.SNAPSHOT      | vCare - Server - Services - DialogFlow - CS7 (Questionnaires)
126 | Active   |  80 | 0.0.3.SNAPSHOT      | vCare - Server - Services - DialogFlow - CS8 (User Feeling)
128 | Active   |  80 | 1.2.0               | CDI APIs
129 | Active   |  80 | 1.2                 | javax.interceptor API
131 | Active   |  80 | 1.2                 | javax.transaction API
133 | Active   |  80 | 1.1.1               | Apache Aries Transaction Blueprint
134 | Active   |  80 | 2.2.0               | Apache Aries Transaction Blueprint
136 | Active   |  80 | 2.6.2               | Apache Commons Pool
137 | Active   |  80 | 2.1.1               | Apache Commons DBCP
152 | Active   |  80 | 4.2.9               | Apache Karaf :: JDBC :: Core
163 | Active   |  80 | 3.3.0.1             | Apache ServiceMix :: Bundles :: cglib
164 | Active   |  80 | 1.0.0.2             | Apache ServiceMix :: Bundles :: javax.inject
183 | Active   |  80 | 1.4.4               | OPS4J Pax JDBC Pooling DBCP2
```

java.exe

Figure 20: The vCare coaching services server listing the software modules currently running (coaching services and helper modules)

The caregiver UI played only a minor role in the TechLab phase and was mainly used to set up the care plans for imaginary test users which are used by knowledge layer to derive and trigger decisions according to the coaching services. The doctors view on a patient is provided in Figure 21. The caregiver UI will play a central role at the upcoming Living Lab phase with close involvement of medical experts.

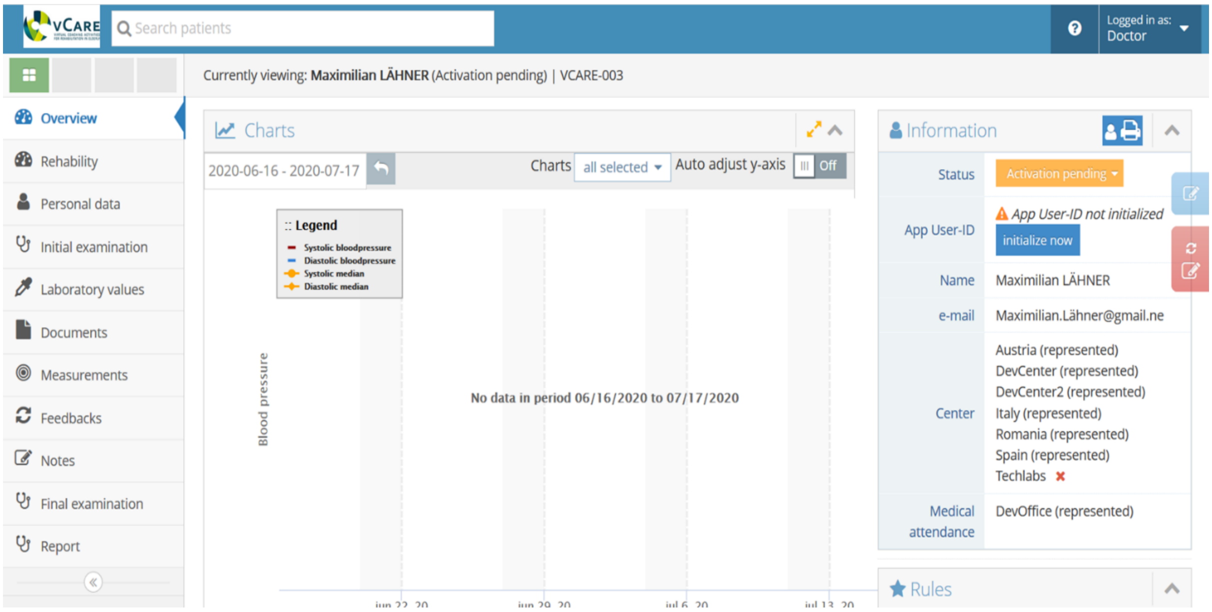

Figure 21: Screenshot of the caregiver UI

4.4 Knowledge Layer Showcase

The knowledge layer is storing information in a RDF triple store. Information is organized in the semantic of **subject, predicate, object**. In the following we have visualized small parts of the knowledge graph to give an idea on how information is process.

Regarding the test execution the individual attributes are simulated and inserted to the knowledge layer. Depending on the test case the reasoner then runs a query over the graph to extract the information needed.

In the example shown in Figure 3 information about a scheduled activity "Serious Game" is included. In this case we receive information about an achieved game score via the MQTT broker and store this information in the graph under the result schema.

The reasoner compares the values and triggers the coaching service message accordingly as documented in the test documentation.

Another example demonstrates the information stored about a patient. On the one hand we track the clinical history. This holds information about the disease the patient is suffering. On the other hand, we store information about the individual clinical state of the patient. Among others we track questioner results and medical examination results. Based on this information the smart agent bases its recommendations about parameterisation of activities.

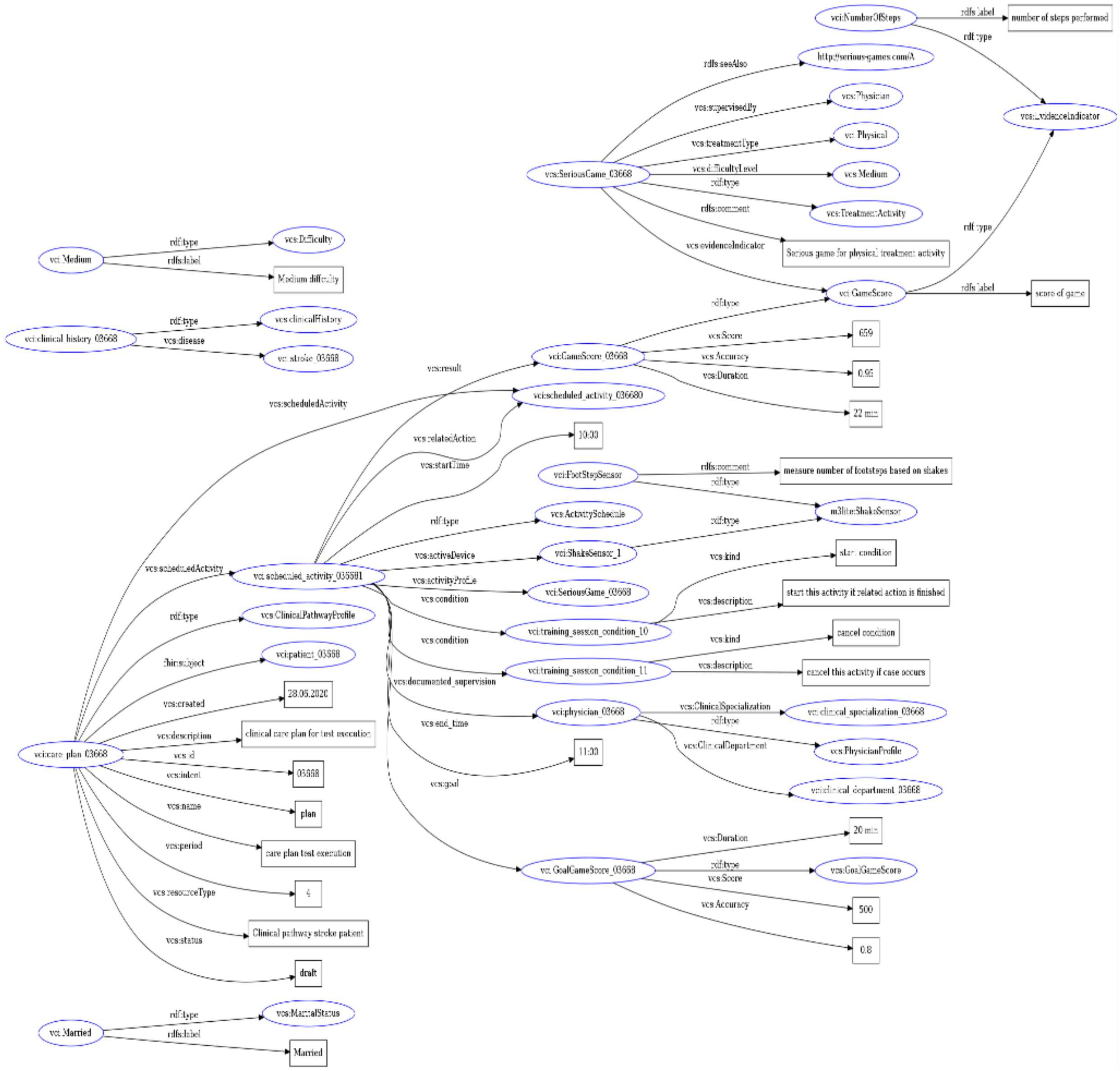

Figure 22: Graph for activity "Serious Game"

Information about patients is stored in a similar form. This includes, for example, more detailed information about the exact disease of the patient and links to other extensive ontologies from which information can be extracted. The patient with a certain ID is mapped as "vci", i.e. vCare instance, the instance itself is of type vcs:patientProfile. This clearly defines which information about an instance should be specified. In addition, the attached section shows how information is linked. The patient has a clinical history, which means that on a general level, information about his clinical history (vcs:clinical_history) is modelled. This predicate is in turn extended in the semantik web by an object, i.e. an individual instance. An instance is assigned to the patient (vci:clinical_history).

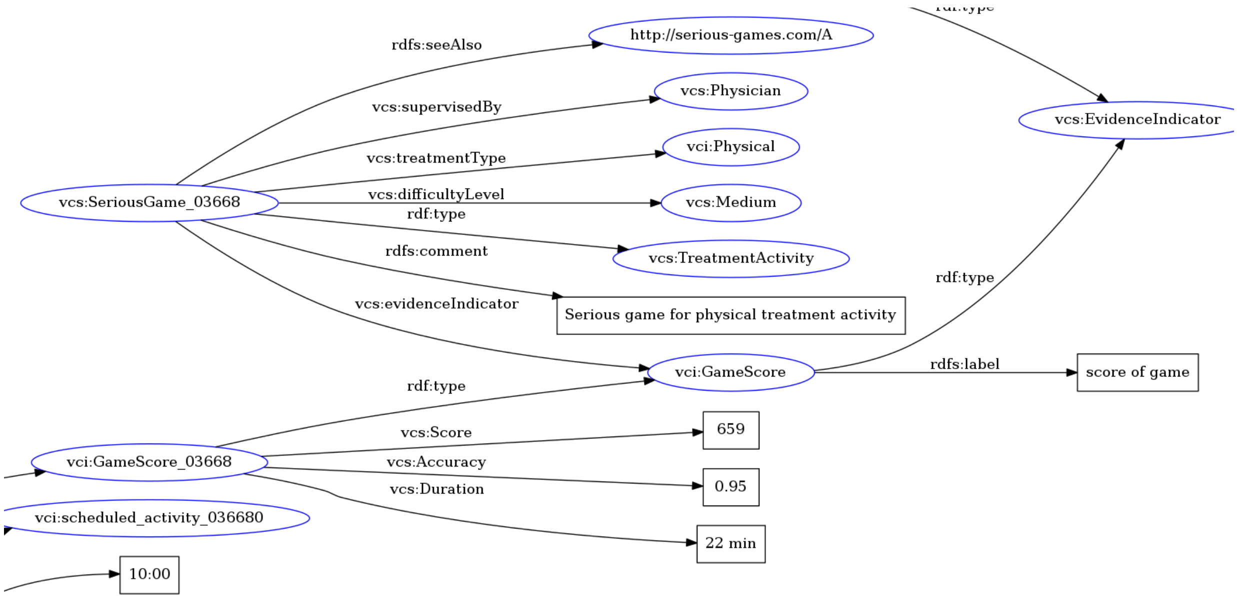

Figure 23: Graph for activity result

The related information stored in the knowledge layer shown in Figure 23 represents a small part of the RDF visualization for all activity related information (shown in Figure 20).

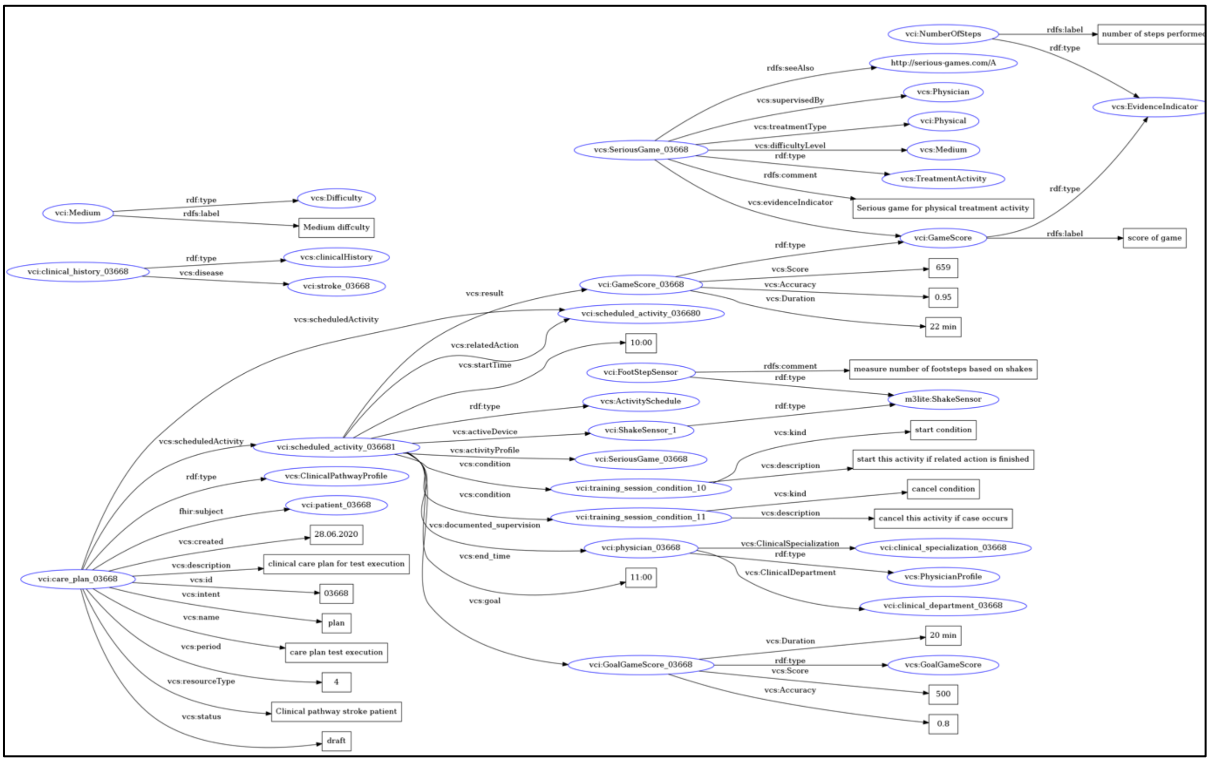

Figure 24: overview activity RDF

4.5 SERIOUS GAMED SHOWCASE

REHABILITY therapist station vCare integration

REHABILITY therapist station has been revamped and adapted to integrate seamlessly with KIOLA pathways backend and permits a single sign on access through keycloack.

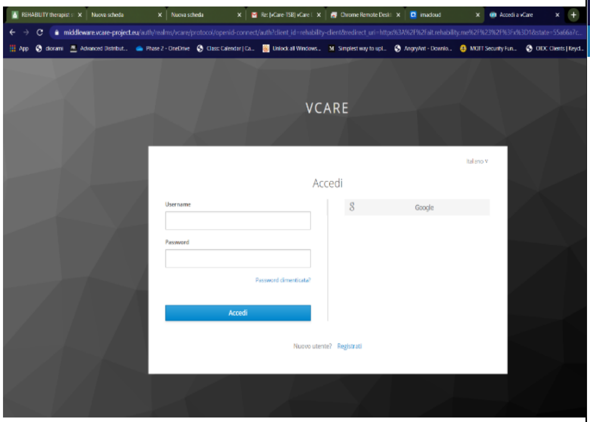

Figure 25: login interface

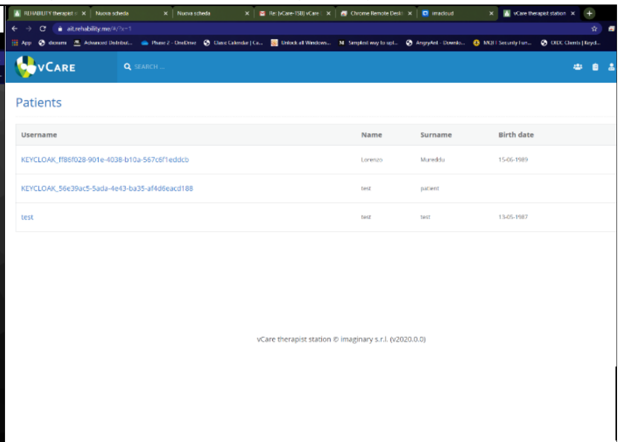

Figure 26: overview Patients

Users are uniquely identified by the KEYCLOACK id and have a specific game profile setting some information useful for the execution of the games.

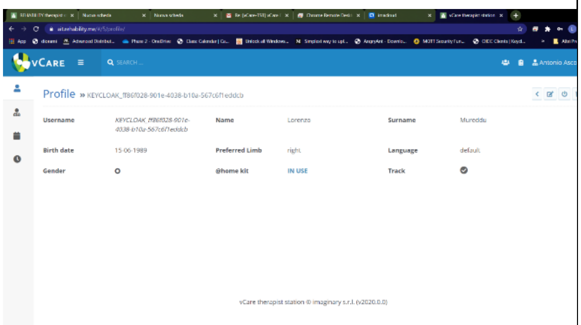

Figure 27: game profiles

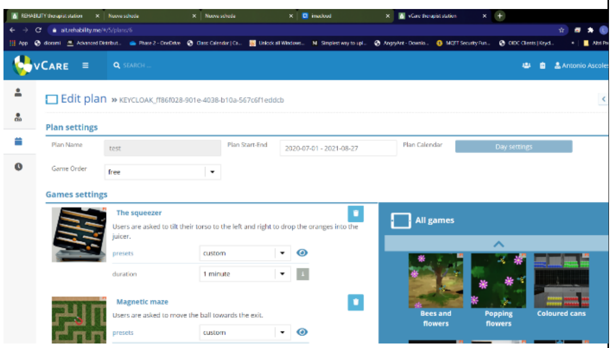

Figure 28: edit game plan

Games are selected for each specific patient and can be costumized via a web application. Results from each game sessions may be accessed through the same portal.

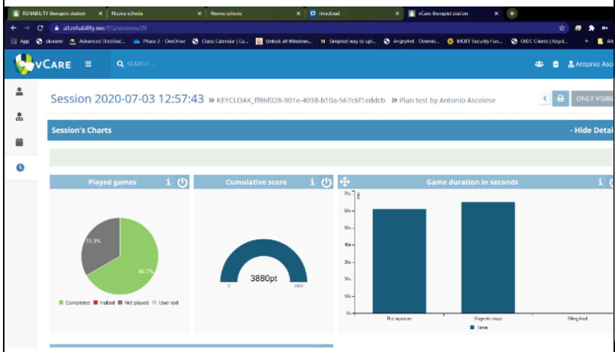

Figure 29: results game session

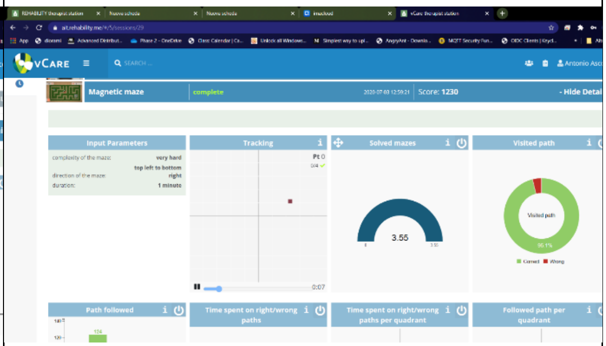

Figure 30: results game

New games

Some new games have been specifically designed to accomplish therapists' specific requests:

Specifically, more games involving legs and balance/leaning were required, like the vacuum cleaner (raising legs to avoid being hit).

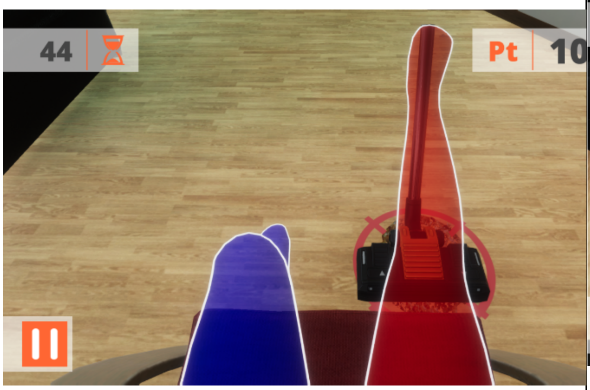

Figure 31: new game leg raise

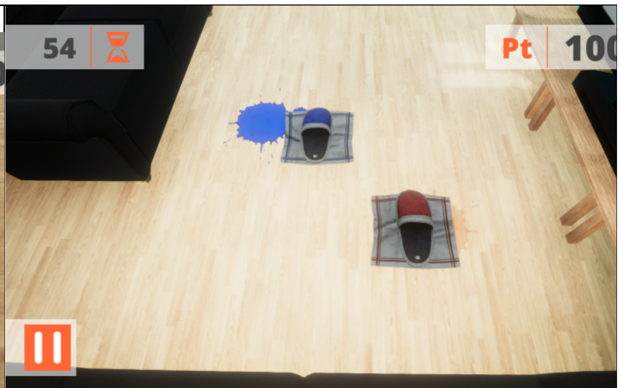

Figure 32: new game move mops

Here the user needs to move the mops to clean the red/blue spots.

Finally, a "skiing game" was added in which the user needs to lean forward in order to avoid hitting the obstacles (Figure 33 and 31).

Figure 33: new game skiing

Figure 34: new game skiing (2)

4.6 MIDDLEWARE AUTHENTICATION AND DATA INTEGRATION

This showcase, made in the context of the TechLabs in Spain, was meant to show all partners integrating services and data in vCare how the MQTT technology works and explain all partners how make the integration using the OAuth2 framework configured (access to MQTT topics based on permissions embedded on an OAuth2 access token emitted by Keycloak).

The demo was structured in the following section:

1) Configure a client in Keycloak to be used to access vCare ecosystem
2) Obtain tokens from Keycloak
3) Publish/subscribe data to MQTT

Client configuration in Keycloak

The procedure to create the client has already described in D7.6 and published in the vCare documentation site[10]. The demo showed a full creation process from scratch, differentiating between the two types of clients that are possible:

a) User clients: meant for services which only handle data from a specific user (e.g., the avatar running at the home of the patient)
b) Service clients, meant to listen to all users in the specific lab/pilot. For example, the knowledge layer, which has to process information from all users.

The distinction between them is made based on client scopes assigned. These scopes are assessed on authentication time to provide one set of permissions or another. Table 18 shows

[10] https://middleware.vcare-project.eu/docs/userguide/authentication/

an excerpt of the access token showing which permissions are granted to users logged through different clients and roles. On the left side, we use a 'User client' and we log in as a 'patient'. The set of permissions allow the client to access only data related to the specific user, published under the topic 'vcare/0ffd1cf7-8a89-4666-8b2d-eaf9843e63b7/#'. The right side shows a service client which allows access to all patient's data on MQTT (topics 'vcare/#').

Table 18: permissions set for different clients in the access_token

Permissions using a user client	Permissions using a service client
"scope": "rabbitmq", **"rabbit_extra_permissions": [** **"rabbitmq.read:lv_spain/*/vcare.0ffd1cf7-8a89-4666-8b2d-eaf9843e63b7.*",** **"rabbitmq.write:lv_spain/*/vcare.0ffd1cf7-8a89-4666-8b2d-eaf9843e63b7.*",** **"rabbitmq.configure:lv_spain/*/vcare.0ffd1cf7-8a89-4666-8b2d-eaf9843e63b7.*",** **"rabbitmq.read:techlabs/*/vcare.0ffd1cf7-8a89-4666-8b2d-eaf9843e63b7.*",** **"rabbitmq.write:techlabs/*/vcare.0ffd1cf7-8a89-4666-8b2d-eaf9843e63b7.*",** **"rabbitmq.configure:techlabs/*/vcare.0ffd1cf7-8a89-4666-8b2d-eaf9843e63b7.*"** **]**	"scope": "rabbitmq", "rabbit_extra_permissions": ["rabbitmq.read:techlabs/*/vcare.*", "rabbitmq.write:techlabs/*/vcare.*", "rabbitmq.configure:techlabs/*/*"]

Obtain tokens from Keycloak

This short demo (Figure 32) showed how to configure clients to query Keycloak for new tokens. The demo used Postman as it can generate similar code for a great list of programming languages.

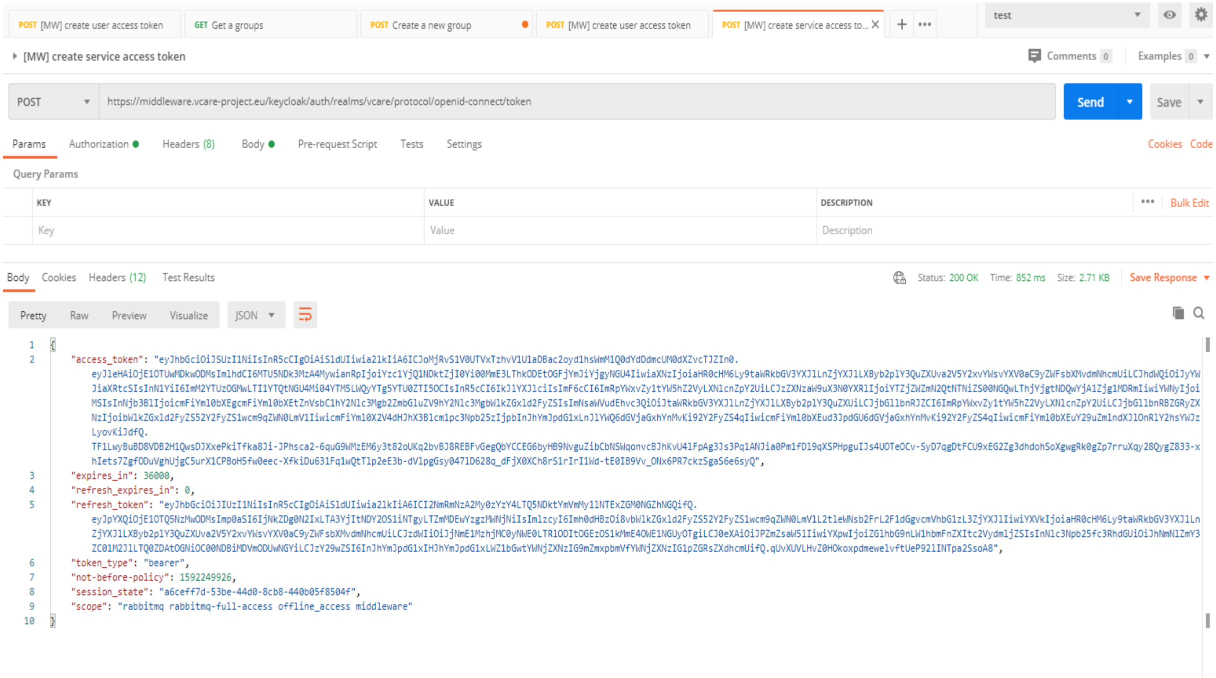

Figure 35: obtain token MQTT

Publish/subscribe data to MQTT

The last part of the demo showed how to access MQTT with the generated access_token (Figure 33). For that it was used MQTT Explorer, which is an appropriate tool to debug problems connecting to MQTT.

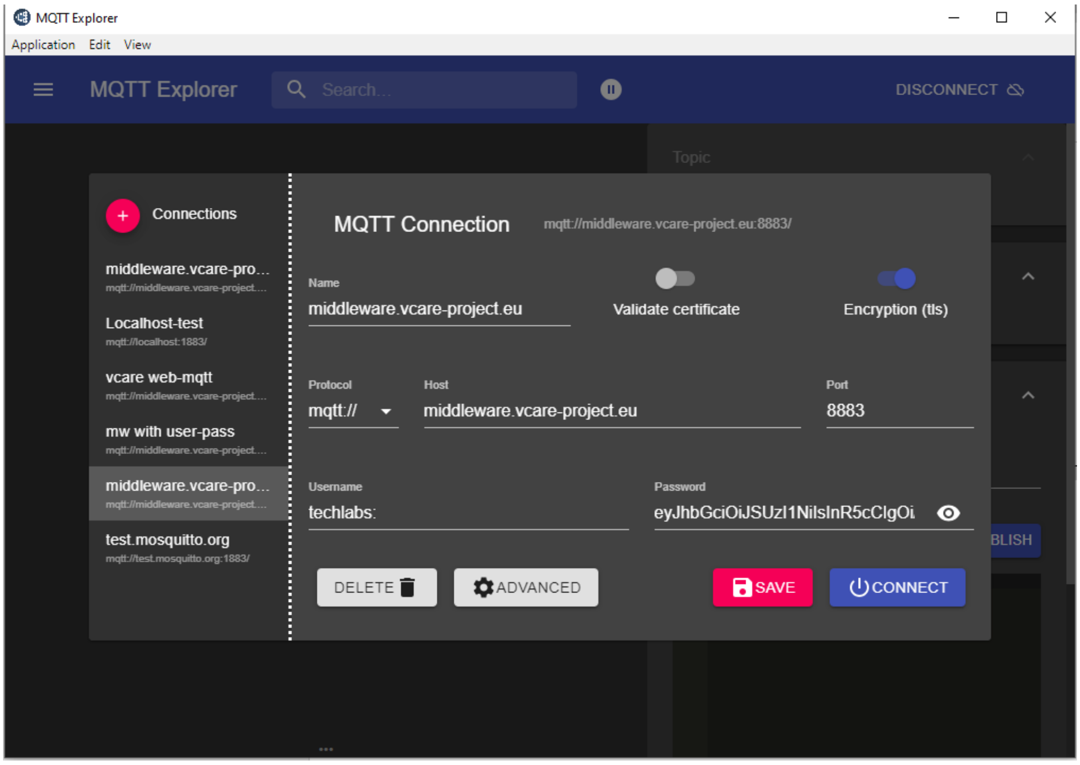

Figure 36: publish data MQTT

5. Iterative Scrum approach

The **Scrum approach** enables software development to prioritize the work that matters most and break it down into manageable chunks. **Scrum** is about collaborating and communicating both with the people who are doing the technical development work (technical partners) and the people who need the work done (medical partners).

As we defined in D7.4, vCare Tech Labs Scrum framework was run using the following terms:

- **Backlog:** the backlog was composed of development, implementation and testing task for every service and requirement as they were defined at the beginning of Tech Labs. In the table below are scheduled the delivery of every requirement and service planned to be implemented and tested in the vCare Tech-Labs phase. All the tasks are recorded and tracked using Atlassian Jira software[11]
- **Sprint:** the length of the sprint was set to 3 weeks. Sprints are run using also Jira.
- **Development team**: a joint team from FZI, AIT, TUD, SIV, IMA and MYS
- **Product owner**: this role was assigned for a person from MYSPHERA
- **Scrum master**: this role was assigned for a person from SIVECO.
- **Sprint planning meetings**: was planned on Fridays at the beginning of every sprint and done using teleconference tool GoToMeeting
- **Sprint reviews and retrospectives**: was planned on Fridays at the end of every sprint and done using teleconference tool GoToMeeting and IdeaBoards online whiteboard tool.

Table 19: coaching service scrum

Coaching Services CS-x		
Code	**1st release**	**Responsible**
CS-1	2020-04	IMA
CS-2	2020-02	AIT, MYS
CS-3	2020-02	IMA
CS-4	2020-06	AIT
CS-5	2020-03	AIT
CS-6	2020-02	AIT, MYS

[11] See: https://www.atlassian.com/software/jira

CS-7	2020-02	AIT
CS-8	2020-03	AIT
CS-9	2020-06	AIT
Data Services DS-x		
Code	**1st release**	**Responsible**
DS-1	2020-02	MYS
DS-2	2020-04	MYS
DS-3	2020-12	MYS
DS-4	2020-04	MYS
DS-5	2020-02	MYS
DS-6	2020-04	MYS
DS-7	2020-06	MYS
DS-8	2020-06	MYS
DS-9	2020-07	AIT
DS-10	2020-03	AIT
Supporting Services SS-x		
Code	**1st release**	**Responsible**
SS-1	2020-02	AIT
SS-2	2020-03	AIT
SS-3	2020-02	AIT
Requirements R2.x		
Code	**1st release**	**Responsible**
R2-1	2020-02	MYS
R2-2	2020-02	MYS
R2-3	2020-04	MYS
R2-4	2020-12	MYS
R2-5	2020-04	MYS
R2-6	2020-04	MYS

R2-7	2020-03	MYS
R2-8	2020-06	MYS
R2-9	2020-06	MYS
R2-10	2020-06	MYS
	Requirements R3.x	
Code	**1st release**	**Responsible**
R3-1	2020-02	AIT
R3-2	2020-04	AIT
R3-3	2020-07	AIT
R3-4	2020-03	AIT
R3-5	2020-03	AIT
R3-6	2020-03	AIT
R3-7	2020-03	AIT
R3-8	2020-02	AIT
R3-9	2020-02	AIT
R3-10	2020-02	AIT
R3-11	2020-02	AIT
R3-12	2020-04	AIT
R3-13	2020-04	AIT
	Requirements R4.x	
Code	**1st release**	**Responsible**
R4-1	2020-02	FZI
R4-2	2020-02	FZI
R4-3	2020-04	FZI
R4-4-1	2020-04	FZI
R4-5	2020-02	FZI
R4-6	2020-06	FZI
R4-7	2020-02	FZI

R4-7-1	2020-02	FZI
R4-7-2	2020-02	FZI
R4-7-3	2020-02	FZI
R4-7-4	2020-02	FZI
R4-7-5	2020-02	FZI
R4-8	2020-02	FZI
R4-9	2020-04	FZI
R4-10	2020-07	FZI
Requirements R5.x		
Code	**1st release**	**Responsible**
R5-1	2020-02	AIT
R5-2	2020-06	AIT
R5-3	2020-02	AIT
R5-4	2020-02	AIT
R5-5	2020-02	AIT
R5-6	2020-03	AIT
R5-7	2020-02	AIT
R5-8	2020-04	IMA
R5-9	2020-02	IMA
R5-10	2020-07	AIT
Requirements R6.x		
Code	**1st release**	**Responsible**
R6-1	2020-04	TUD
R6-1-1	2020-04	TUD
R6-1-2	2020-04	FZI
R6-2	2020-03	TUD
R6-2-1	2020-03	TUD
R6-3	2020-06	FZI

Requirements R7.x		
Code	**1st release**	**Responsible**
R7-1	2020-02	MYS
R7-2	2020-02	MYS
R7-3	2020-02	MYS
R7-4	2020-04	MYS
R7-5	2020-03	MYS
R7-6	2020-04	FZI
R7-7	2020-06	MYS

5.1 Visualization of JIRA Board time line

Atlassian Jira software was used for task definition and progress tracking. In the TechLabs phase we have run 5 sprints.

At the beginning of every sprint all the technical partners, the product owner and the scrum master joined in spring planning meeting. They analysed every task of the current sprint, looking for their acceptance criteria and decided if the status of the task was completed or still in progress. The tasks that are not completed were transferred in the next sprint. Also the team involved in the planning meeting picked up more tasks from the backlog and move them in the new sprint, according to their availability to work along the whole period of the new sprint, and assign them to the developers.

During the sprint, the developers started to work on their tasks assigned, turned them from "To Do" status to "In Progress" status, and, depending the difficulty of that task, created new subtasks, added comments, added log files or other useful documents, and linked the tasks to other related to, for an easy way to track the progress. At the end of their workday, the developers logged their work by adding their time spent on that task, and changed the task estimation if they considered necessary. Finally, they establish the overall progress of the task.

The table below – exported from Jira board – illustrates the assignment of vCare Tech-Labs tasks on every sprint, as well as their statuses at the end of last sprint.

Table 20: Jira Board sprints

Jira Key	Summary	Assignee	Status	Sprint Done
Sprint 1: 27/Mar/20 - 17/Apr/20				
VTL-1	CS-2 Health status	Emanuel Sandner	Done	Sprint 4
VTL-2	CS-6 Intelligent notification/scheduler	Emanuel Sandner	Done	Sprint 5
VTL-3	CS-7 Medical questionnaires	Emanuel Sandner	Done	Sprint 4
VTL-4	DS-1 Location in the house	Alvaro Martinez	Done	Sprint 5
VTL-5	DS-5 Monitoring of vital parameters	Mircea Vasile	Done	Sprint 3
VTL-6	SS-1 Weather (Backend Service)	Emanuel Sandner	Done	Sprint 2
VTL-7	SS-3 Standby (Backend Service)	Emanuel Sandner	Done	Sprint 2
VTL-8	R2-1 Home's room detection	Alvaro Martinez	Done	Sprint 5
VTL-9	R2-2 Outdoors detection	Alvaro Martinez	To Do	
VTL-10	R3-1 Coach main interactive application, the AVATAR	Emanuel Sandner	Done	Sprint 4

VTL-11	R3-8 Caregiver interface for therapy and goals setting	Emanuel Sandner	Done	Sprint 3
VTL-12	R3-9 Caregiver interface for patient management	Emanuel Sandner	Done	Sprint 3
VTL-13	R3-10 Weather info	Emanuel Sandner	Done	Sprint 2
VTL-14	R3-11 Standby mode	Emanuel Sandner	Done	Sprint 2
VTL-15	R4-1 Knowledge aggregation and profile generation	Lars Boecking	Done	Sprint 3
VTL-16	R4-2 Knowledge mediation	Patrick Philipp	Done	Sprint 3
VTL-17	R4-5 Coaching activities recommender	Lars Boecking	Done	Sprint 4
VTL-18	R4-7 Prediction of target deviations	Patrick Philipp	In Progress	
VTL-19	R4-7-1 Weight and body water content significant deviation detection	Patrick Philipp	In Progress	
VTL-20	R4-7-2 HR and BP significant deviation detection	Patrick Philipp	In Progress	
VTL-21	R4-7-3 Cholesterol significant deviation detection	Patrick Philipp	To Do	
VTL-22	R4-7-4 Glucose significant deviation detection	Patrick Philipp	To Do	
VTL-23	R4-7-5 Medication adherence deviation detection	Patrick Philipp	To Do	
VTL-24	R4-8 Repository of machine learning models	Patrick Philipp	To Do	
VTL-25	R5-1 Coaching mediation	Emanuel Sandner	In Progress	
VTL-26	R5-3 Notifications and reminders	Emanuel Sandner	Done	Sprint 3
VTL-27	R5-4 Agenda	Emanuel Sandner	Done	Sprint 3
VTL-28	R5-5 Health status	Emanuel Sandner	Done	Sprint 4
VTL-29	R5-7 Questionnaires	Emanuel Sandner	Done	Sprint 4
VTL-30	R5-9 Cognitive training	Vito Nitti	Done	Sprint 5
VTL-31	R7-1 Vital signs monitoring	Octavian Miu	Done	Sprint 4
VTL-32	R7-2 Fitbit, outdoors and indoors physical activity monitoring	Octavian Miu	Done	Sprint 4

VTL-33	R7-3 Blood pressure monitoring	Octavian Miu	Done	Sprint 4
VTL-34	Configuration of authentication server	Alvaro Martinez	Done	Sprint 1
VTL-87	Install a docker registry to upload vcare related images	Alvaro Martinez	Done	Sprint 1
Sprint 2: 17/Apr/20 - 8/May/20				
VTL-41	CS-5 Rehabilitation coach	Emanuel Sandner	Done	Sprint 3
VTL-42	CS-8 User feeling	Emanuel Sandner	Done	Sprint 4
VTL-43	DS-10 Detection of sleep quality	Emanuel Sandner	Done	Sprint 4
VTL-44	SS-2 Agenda	Emanuel Sandner	Done	Sprint 3
VTL-45	R2-7 Home inactivity detection	Alvaro Martinez	Done	Sprint 5
VTL-46	R3-4 Registering info and questionnaires interface	Emanuel Sandner	To Do	
VTL-47	R3-5 Report interface	Emanuel Sandner	In Progress	
VTL-48	R3-6 Information interface	Emanuel Sandner	Done	Sprint 4
VTL-49	R3-7 Agenda interface	Emanuel Sandner	Done	Sprint 5
VTL-50	R5-6 User feelings	Emanuel Sandner	Done	Sprint 4
VTL-51	R6-2 Editing of Clinical Pathways - Modeling Tool	Hannes Schlieter	Done	Sprint 5
VTL-52	R6-2-1 Management of clinical pathways	Hannes Schlieter	Done	Sprint 5
VTL-53	R7-5 Medication adherence deviation detection	Alvaro Martinez	To Do	
VTL-54	R5-8 Physical Training	Vito Nitti	Done	Sprint 3
VTL-149	CS-3 Cognitive training	Vito Nitti	Done	Sprint 5
VTL-59	Deploy the vCaaS swagger docs	Alvaro Martinez	Done	Sprint 2
Sprint 3: 8/May/20 - 29/May/20				
VTL-63	CS-1 Physical Training	Vito Nitti	Done	Sprint 3
VTL-64	DS-2 Body position detection	Alvaro Martinez	Done	Sprint 5
VTL-65	DS-4 Fall detection	Alvaro Martinez	Done	Sprint 5

VTL-66	DS-6 Monitoring of physical activity level	Alvaro Martinez	Done	Sprint 5
VTL-67	R2-3 Body position detection	Alvaro Martinez	Done	Sprint 5
VTL-68	R3-2 Adaptation of the user interface	Emanuel Sandner	To Do	
VTL-69	R3-12 Dynamic content app	Emanuel Sandner	To Do	
VTL-70	R3-13 Video playback interface	Emanuel Sandner	In Progress	
VTL-71	R4-3 Automatic extraction of patient trends and coaching activities personalization	Lars Boecking	In Progress	
VTL-72	R4-4-1 Clinical pathway personalization and contextualization	Patrick Philipp	To Do	
VTL-73	R4-9 Access time-series data	Patrick Philipp	Done	Sprint 4
VTL-74	R5-8 Physical training	Vito Nitti	Done	Sprint 4
VTL-75	R6-1 Adaptive clinical pathways	Kai Gand	In Progress	
VTL-76	R6-1-1 Adaptive clinical pathways - manual adaptation	Kai Gand	Done	Sprint 5
VTL-77	R6-1-2 Adaptive clinical pathways - automatic adaptation	Lars Boecking	Done	Sprint 5
VTL-78	R7-4 Weight and body water content monitoring	Octavian Miu	Done	Sprint 5
Sprint 4: 29/May/20 - 19/June/20				
VTL-79	R7-6 Cholesterol monitoring	Patrick Philipp	Done	Sprint 5
VTL-85	Data collection from scale	Octavian Miu	Done	Sprint 5
VTL-89	Deployment of the pathway subsystem	Alvaro Martinez	Done	Sprint 5
VTL-100	Initial deployment of vCaaS services	Alex Vulpe	In Progress	
VTL-101	Authentication flow between vCaaS and KeyCloak	Alex Vulpe	In Progress	
VTL-102	Implement authentication flow of CC2U login service and vCaaS	Akis Idrizi	In Progress	
VTL-103	Simulate messages sent to/from a vCare module to vCaaS	George Matikas	In Progress	

VTL-104	End-to-end testing of CC2U-vCaaS-vCare interaction	Razvan Craciunescu	In Progress	
VTL-105	Authentication flow between vCaaS and KeyCloak - service (all users)	Alex Vulpe	In Progress	
VTL-110	Authentication flow between vCaaS and KeyCloak - user and password	Alex Vulpe	In Progress	
Sprint 5: 19/June/20 - 10/July/20				
VTL-119	CS-4 e-Learning	Emanuel Sandner	Done	Sprint 5
VTL-120	CS-9 Speech and swallowing therapy	Emanuel Sandner	To Do	
VTL-121	DS-7 Detection of activity of daily living	Alvaro Martinez	Done	Sprint 5
VTL-122	DS-8 Social monitoring	Alvaro Martinez	To Do	
VTL-123	R2-8 Home behaviour monitoring	Alvaro Martinez	Done	Sprint 5
VTL-124	R2-9 Deviation behavoiur detection	Alvaro Martinez	Done	Sprint 5
VTL-125	R2-10 Social monitoring	Alvaro Martinez	To Do	
VTL-126	R4-6 Personalized and context-aware interaction and feedback	Patrick Philipp	Done	Sprint 5
VTL-127	R5-2 e-Learning	Emanuel Sandner	Done	Sprint 5
VTL-128	R6-3 Derive the daily agenda from clinical pathways	Patrick Philipp	In Progress	
VTL-129	R7-7 Medication adherence monitoring	Alvaro Martinez	Done	Sprint 5
VTL-130	Define persistency in the pathway components	Alvaro Martinez	Done	Sprint 5
VTL-144	Deploy vcare ontology and make it publicly available	Alvaro Martinez	In Progress	

5.2 Non functional requirements

The list of Non-Functional requirements was defined in **T7.2** Translation to technical requirements - final version, and the selection of non-functional requirements for the Tech-Labs phase was made in **T7.4** Specification of the whole architecture – as shown in the Figure 34:

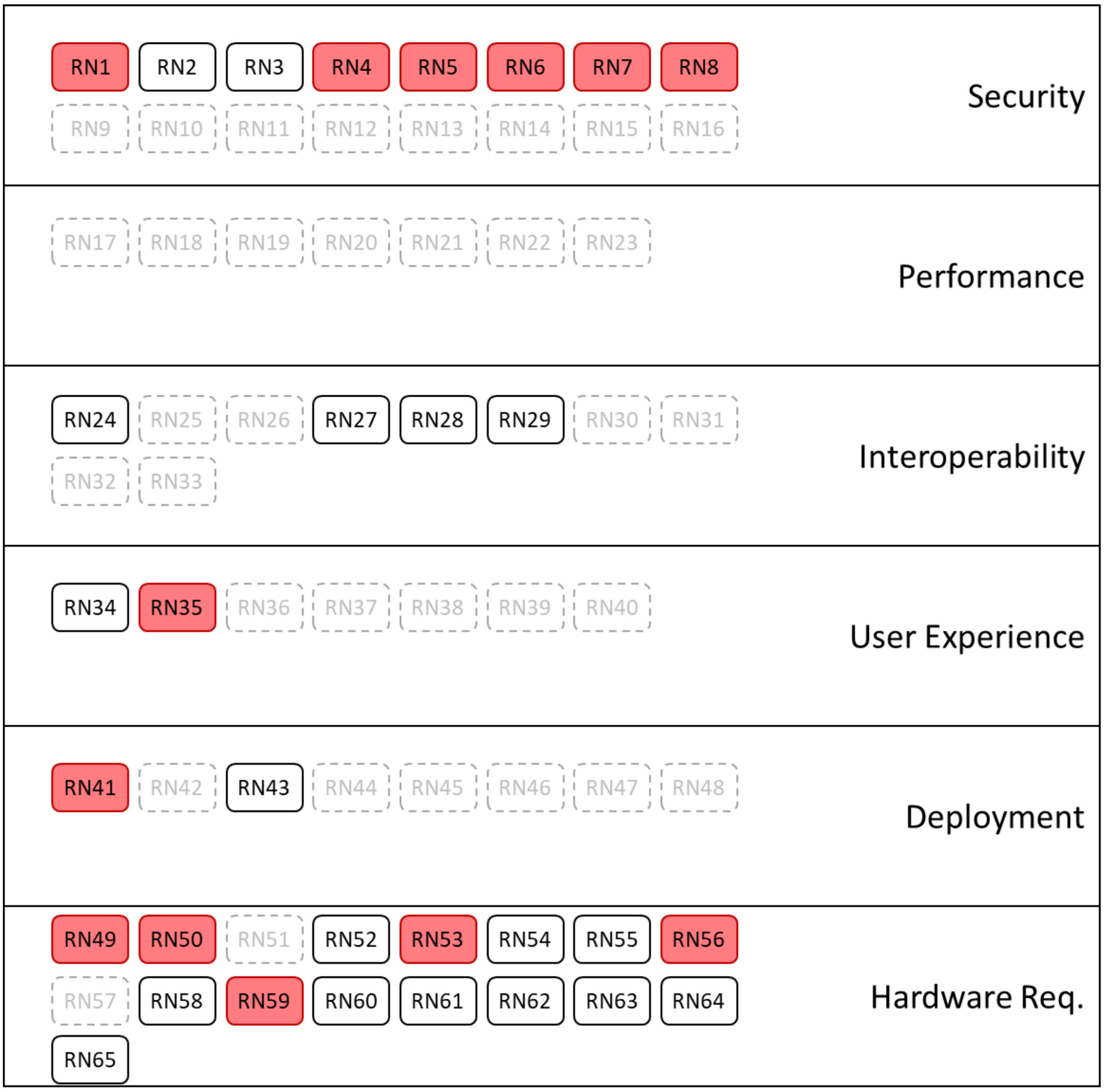

Figure 37 – Selection of non-functional requirements for Tech-Labs phase

The testing in the Tech-Lab phase of these non-functional requirements was done following some acceptance criteria defined for every specific requirement, as displayed in Table 21:

Table 21: non-functional requirements acceptance criteria

Code	Name	General acceptance criteria	Test procedure
RN1	Strong authentication	The user logged in must use a strong password having minimum eight characters, letters, capitals and special characters. The password must have an availability period of maximum two months.	If the user log in the platform and the password is strong enough according to the acceptance criteria, the test passes.
RN2	Single Sign-on	The vCare platform must have a single sign-on mechanism, so the user signs-in only the first application.	If the user log in the platform only in the first application of vCare platform and stays logged in when access other applications in the same session, the test passes.
RN3	Identity Management	The platform must ensure the authentication and authorization integrated using an identity management suite as done by FIWARE and Keycloak implementation.	If the user has the same identity (username, password, user details) for all the vCare components and his credentials were set only one time in Keycloak, the test passes.
RN4	Security of the time-series data	Time-series data must be logically isolated for every user by using implementation of JWT.	If the user data are accessible only to the user for whom it was intended, the test passes.
RN5	Session time out	Session timeout must be implemented and disconnection will occur after max. 24h of inactivity.	If the session has no activity and disconnects after a period according to the acceptance criteria, the test passes.
RN6	Access policies	Every user must have granted specific access policies accordingly to their roles so only authorised persons can access the system (according to GDPR)	If the user accesses only applications and functionality for whom was granted by the administrator, the test passes.
RN7	Strong encryption	The connection must be encrypted using a 2048-bit SSL certificate.	If the user connects to vCare using a SSL certificate according to the acceptance criteria, the test passes.
RN8	VPN	The connection between subsystems must be done using a VPN.	This non-functional requirement is obsolete because the end user can't use a VPN to access vCare platform.
RN24	FIWARE interoperability	The system must use FIWARE as a standard IoT open platform for the integration of data.	If the IoT components accesses middleware using the FIWARE open platform, the test passes.

			For the non-Iot components the test is not applicable.
RN27	FISTAR interoperability	FISTAR technologies must be used in order to integrate the health monitoring tools and FIWARE.	If the health monitoring tools uses technologies from FISTAR to integrate with FIWARE the test passes. For the other tools is not applicable.
RN28	Semantic approach	Different context domain must be integrated using a semantic approach as part of vCare's ontology.	If the component uses messages based on specific topics defined in MQTT, the test passes.
RN29	Semantic technology	The events processed in the knowledge layer must be semantically annotated using JSON-LD contexts and must reference to Internationalized Resource Identifiers (IRIs) such as schema.org	If a running process sends messages using JSON-LD and addresses schemas in the knowledge layer, the test passes.
RN34	Bluetooth devices	Measurements must be taken with high accuracy using Bluetooth device, with minimum manipulation.	If the application uses a Bluetooth device for transmitting measurement, the test passes. The test is not applicable for components that do not have Bluetooth devices.
RN35	Minimal technology	The patient's devices must be optimized for obtaining most of the measurements with a few functionalities as possible.	If the application that interacts with the patients does not affect their attention apart from the scope of the requirement, the test passes. The test is not applicable for other applications.
RN41	Containerization, microservices architecture	The application must use microservices (like Docker containers).	If the component runs in a Docker container, the test passes. For the components that are not suitable for running in Docker containers, the test is not applicable.
RN43	Distributed deployment (development phases)	The application must be deployed on one of the technical partner's (MYS, AIT, FZI) servers.	If the application is deployed according to the acceptance criteria, the test passes.
RN49	Activity/PD monitoring device	The user must wear a fall sensor in order to detect, apart from falls also body position and motor symptoms.	If the application uses a fall sensor, the test passes. Not applicable in absence of fall sensors.

RN50	Weight body water scale	The patients with cardiovascular diseases must use a Bluetooth weight scale.	If the application uses a Bluetooth weight scale, the test passes. Not applicable in absence of weight scale.
RN52	BP/HR monitoring device	The patients must use a Bluetooth blood pressure device.	If the application uses a Bluetooth blood pressure, the test passes. Not applicable in absence of blood pressure.
RN53	Fitbit device	The patient must wear a Bluetooth smartwatch or a fitbit-like device on his wrist in order to transmit heart rate and activity measurements.	If the application uses a Bluetooth activity device for heart rate and number of steps measurements, the test passes. Not applicable in absence of the activity device.
RN54	Access sensor data	The sensor must send data in the platform directly or using a gateway.	If the application uses sensors that send data successfully in the vCare platform, the test passes. Not applicable in absence of sensors.
RN55	Presence sensors	Presence sensors must be used in this test in order to enable spatial behaviour detection.	If the application uses presence sensors, the test passes. Not applicable in absence of presence sensors.
RN56	Magnetic sensors	Magnetic sensors must be used in this test, to check when patient leaves home.	If the application uses magnetic sensors, the test passes. Not applicable in absence of magnetic sensors.
RN58	Gateway	The Smart Home gateway must run on a tablet.	If the application is belonging to the Smart Home suite and run on a tablet, the test passes. For other applications is not applicable.
RN59	Fall and activity sensor	A fall sensor integrated with the Smart Home must be used in this test.	If the application uses a fall sensor integrated with the Smart Home, the test passes. Not applicable in absence of fall sensors.
RN60	AVATAR	The AVATAR main application must run in this test.	If the functionality implies the AVATAR application, the test passes. Not applicable in absence of AVATAR.

RN61	Other coaching apps	The application must be integrated in the same device together with the AVATAR.	If the application is running on the same device together with the AVATAR, the test passes.
RN62	Set top box	A set top box running games application must be used in this test.	If the application runs serious games from a set top box device the test passes. Not applicable in absence of serious games applications.
RN63	Kinect	A kinect like solution must run in this test.	If the serious games applications use a Kinect device, the test passes. Not applicable in absence of serious applications.
RN64	Server	This application must run on a server with a specific configuration.	If the application runs on a server at an acceptable performance level, the test passes (the configuration will be specified).
RN65	Internet	This test must use an internet connection.	If the application uses an internet connection at an acceptable performance level, the test passes.

In the *Annex Non Functional Requirements vs Functional Requirements Tests Matrix* is illustrated a matrix that represents the tests of the non-functional requirements made on every requirements and, if the acceptance criteria are fulfilled, the tests are passed (green cells) or some exception occurred and the test failed (red cells). The non-functional requirements that apply to functionals for which tests are not completed are figured in yellow. Some of the tests have measurable results that are displayed separately in the cell or using footnotes. The meaning of the white cells from the matrix is that the non-functional requirement is not applicable for that functional requirement.

6. Summary Results Study Protocol - Requirement Traceability Matrix

In the following we give an extensive documentation for each of the test cases defined in D1.5. To give an overview we start by summarizing the test status in a requirement traceability matrix (Table 22: Requirement Traceability Matrix). In the table, the technical requirements from D7.4 are mapped with the test cases for the particular diseases as defined in D1.5. The table also provides a first overview of the test results. In case that a test execution would be similar for several test cases, the test is, for the sake of efficiency, not conducted and documented for a second time but a respective reference to the primary test is provided. The detailed descriptions follow in chapter 7.

Table 22: Requirement Traceability Matrix

Requirement Reference	Requirement Description	Disease	Testcases ID	Status
R2-1	Home's room detection	Stroke	A-6 SD – DS1	Passed
		Parkinson	A-2 PD – DS1	Same as A-6 SD – DS1
		Heart Failure	A-12 HF – DS1	Same as A-6 SD – DS1
R2-3	Body position detection	Stroke	A-1 SD – DS2	Passed
		Parkinson	A-1 PD – DS2	Same as A-1 SD – DS2
		Heart Failure	A-14 HF – DS2	Same as A-1 SD – DS2
		Ischemic Heart	A-14 IHD – DS2	Same as A-1 SD – DS2
R2-5	Fall detection	Parkinson	A-11 PD – DS4	adjusted
R2-6	Activity Monitoring	Stroke	A-2 SD – DS1	Passed
		Parkinson	A-2 PD - DS1	Passed
		Ischaemic Heart	A-20 IHD – DS1	Same as A-2 SD – DS1
R2-7	Home inactivity detection	Stroke	A-1 SD – CS6 A-2 SD – DS1	Passed Passed
		Parkinson	A-1 PD – CS6 A-2 PD – DS1	Same as A-1 SD – CS6

			A-5 PD – CS6 A-15 PD – CS6	Same as A-2 SD – DS1 Same as A-2 PD – CS6 Passed
		Heart Failure	A-12 HF – CS6 A-12 HF – DS1 A-14 HF – CS6 A-15 HF – CS6	Same as A-1 SD – CS6 Same as A-1 SD – DS1 Same as A-2 SD – DS1 Same as A-15 PD – CS6
		Ischaemic Heart	A-14 IHD – CS6	Same as A-2 SD - DS1
R2-8	Home Behaviour Monitoring	Stroke	A-2 SD – DS7	Passed
		Parkinson	A-2 PD – CS6 A-5 PD – CS6 A-15 PD – CS6	Same as A-2 PD – DS7 Same as A-3 SD – DS7 Passed
		Heart Failure	A-3 HF – DS7 A-12 HF – CS6 A-15 HF – CS6	Passed Same as A-3 SD – CS6 Same as A-15 PD – CS6
R2-9	Deviating behaviour detection	Stroke	A-3 SD – DS7	Passed
		Parkinson	A-2 PD – DS7 A-3 PD – DS7	Passed Same as A-3 SD – DS7
		Heart Failure	A-3 HF – DS7	Passed
		Ischaemic Heart	A-3 IHD – DS7	Same as A-2 PD – DS7
R2-10	Emotion recognition	Heart failure	A-19 HF – DS9 A-19 HF – DS8	Partially passed adjusted

		Ischaemic Heart	A-19 IHD – DS8 A-19 IHD – DS9	Same as A-8 HF – DS8 Same as A-8 HF – DS9
R3-1	VC main interactive application	Stroke	A-1 SD - SS2 A-2 SD – CS6 A-3 SD – SS2 A-5 SD – CS6	Passed Passed Passed Passed
		Parkinson	A-2 PD – CS6 A-5 PD – CS6 A-15 PD – SS2	Passed Passed Passed
		Heart failure	A-14 HF – SS2 A-15 HF – SS2 A-17 HF – SS2 A-18 HF – SS2 A-19 HF – SS2	Passed Passed Passed Passed Passed
		Ischemic Heart	A-3 IHD – SS2 A-15 IHD – CS6 A-18 IHD – SS2 A-21 IHD – SS2	Passed Same as A-15-IHD-CS6 – R5.3 Passed Passed
R3-6	Information Interface	Stroke	A-1 SD – CS5 A-2 SD – CS6 A-5 SD – CS6	Passed Passed Passed
		Parkinson	A-5 PD CS5 A-15 PD CS6	Passed Passed
		Heart failure	A-12 HF - CS6 A-13 HF - CS5 A-15 HF – CS6	Passed Passed skipped
		Ischemic Heart	A-15 IHD – CS6	Same as A-15-IHD-CS6 – R5.3

			A-20 IHD – CS5	Same as A-2-SD-SS1 – R3.10
R3-7	Agenda interface	Stroke	A-1 SD – SS2	Passed
		Heart failure	A-3 HF - SS2	Passed
		Heart failure	A-13 HF SS2	Passed
R3-10	Weather information	Stroke	A-2 SD - SS1	Passed
R3-11	Standby mode	Parkinson	A-2 PD – SS3	Passed
R4-6	Personalized and context-aware interaction and feedback	Stroke	A-1 SD – CS5 A-2 SD - CS5	A-1 SD – CS5 – R4-6 passed A-2 SD - CS5 - R4-6 passed
		Parkinson	A-5 PD -CS5	A-5 PD -CS5 - R4-6 passed
		Heart failure	A-12 HF - CS5	A-12 HF - CS5 - R4-6 passed
		Ischemic Heart	A-13 IHD - CS5	A-13 IHD - CS5 - R4-6 passed
R5-2	E-learning	Stroke	A-3 SD – CS4 A-3 SD – CS4	Passed Passed
		Heart failure	A-3 HF – CS4 A-17 HF – CS4 A-18 HF – CS4	Passed Passed Passed
		Ischemic Heart	A21 IHD – CS4	Passed
R5-3	Notification and reminders	Parkinson	A-2 PD – CS6	Passed
		Heart failure	A-12 HF – CS6 A-13 HF - CS6 A-15 HF – CS6	Passed Passed Passed
		Ischemic Heart	A-13 IHD – CS6	Passed

			A-15 IHD – CS6	Passed
R5-4	Agenda	Parkinson	A-15 PD CS6	skipped
R5-5	Health status	Stroke	A-1 SD – CS2 A-2 SD – CS2	Passed Passed
		Parkinson	A-1 PD – CS2	Passed
		Heart failure	A-12 HF – CS2 A-13 HF – CS2 A-14 HF – CS2 A-17 HF – CS2	Passed Passed Passed Passed
R5-6	User feeling	Stroke	A-1 SD – CS8 A-2 SD – CS8	Passed Passed
R5-7	Medical questionnaires	Stroke	A-9 SD – CS7	Passed
		Ischemic Heart	A-21 IHD – CS7	Passed
R5-8	Physical training	Heart failure	A-14 HF – CS1	Passed
R7-1	Vital stats control	Heart Failure	A-15 HF – DS5	Passed
R7-2	Activity tracker, outdoors and indoors physical activity monitoring	Heart Failure	A-15 HF – DS5 A-16 HF – DS5	Passed
R7-3	**Blood pressure monitoring**	Heart Failure	A-15 HF – DS5	Passed
R7-5	**Glucose monitoring**	Ischaemic Heart	A-15 IHD – DS5	adjusted
R7-6	Cholesterol monitoring	Ischemic Heart	A-15 IHD – DS5	Passed

7. Tech Lab Phase–Test Report

We now present the report for the Tech Lab test cases. We therefore first revisit the test case descriptions presented in D1.5 in order to set the grounds for thoroughly describing the test preconditions, how individual tests are conducted, what results are achieved and how the latter are validated.

Due to the COVID-19 situation, travelling to the respective Tech Lab sites was not possible for both, technical- and medical partners. In order to test and validate the vCare system, we therefore focussed on conducting semi-integrated tests.

A semi-integrated test tests the same functionality as the optimal, fully-integrated test, but allows that only a sub-system of the vCare architecture is executed and/or preconditions of the test to be partially simulated (while still being fulfilled). Here, simulated preconditions refer to artificial data which is already structured according to the vCare ontology and therefor follows a data format which can be interpreted by the involved partners and which is sensible in that it represents realistic entities and properties (e.g., patient information, individual serious games or events transmitted through devices).

As a consequence, the documented semi-integrated tests still guarantee a transition to the Living Lab phase, where vCare components are tested and improved with medical experts, since functionalities of vCare components are extensively evaluated.

7.1 Activity test report–Stroke

A Test case for each one of the following Activities related to Stroke Disease (SD) listed in D1.4 – Annex 6.6 has been defined and will be described henceforth:

Table 23 - List of Activities related to Stroke Disease (SD) as listed in D1.4 - Annex 6.6

Activity (A)	**A #**	**Other Paths**	**Medical Use Case UC #**	**Needs**	**Medical Priority (1=high, 4=low)**
Home-based motor activities	A -1	PD	UC1, UC5, UC6	Physical therapy	1
Coaching for an active lifestyle	A -2	PD	UC1, UC4, UC5, UC6	Physical therapy	4
E-learning	A -3	PD, HF, IHD	UC1, UC2, UC5, UC6, UC7, UC9, UC10, UC11	Physical therapy, Cognitive training, Risk Factor Modification.	3
Home-based cognitive games	A -4	PD	UC3, UC4, UC6	Cognitive training	2
Fun supporting activities	A -5	PD	UC3	Cognitive training	4

Monitoring indoor	A -6		UC1, UC2	Risk Factor Modification	1
Safety tips	A -7		UC2	Risk factor Modification	4
Monitoring mood	A -8	PD, IHD	UC3, UC4, UC5, UC13	Emotional and Social rehabilitation	3
Monitoring pain and sleep	A -9	PD	UC1	Pain	4

7.1.1 Test report Activity A-1 SD: Home-based motor activities

Services and Requirements enhancing the Activity

Service Needs (WP5)		**Functional Requirements (WP7)**
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Physical Training	CS-1	R5-8
Health status	CS-2	R5-5
Rehabilitation coach	CS-5	R3-6, R4,6
Intelligent notifications scheduler	CS-6	R2-7, R2-8, R3-1, R3-6, R5-3, R5-4
User Feeling	CS-8	R5-6
Body position detection	DS-2	R2-3
Agenda	SS-2	R3-1, R3-7

Test case

Activity: HOME-BASED MOTOR ACTIVITIES	
Initial setting: As part of the First narrative/Use Case #1, Maria profile is at discharge from the hospital composed by **ONTOLOGY** (from D1.3/D4.2): – "**Patient profile**": pathology (e.g. stroke), clinical data depicting the clinical syndrome, rehabilitation goals for the body district to be recovered (e.g. upper limbs) – "**Clinical State**": ARAT – "**Evidence Indicators**": Serious game scores – **"Activity":** physical rehabilitation treatment composed by 5 games for the impaired district – **"Time Event":** contain the sequences of rehabilitation treatments (e.g. 30 minutes/day, 3 days/week) – **"Assessment Documents":** the VC system sends a concise report (document) to the caregiver **REASONER** (from D1.3): – Rules for exceptional procedure (Rules D1.3 pg. 51, [*Use Case: UC1. Linked Measure: Pain; VAS Scale*]) – positive feedback after game (Rules D1.3 pg. 50, [*Use Case: UC1 Linked Measure: Game score (to manage Feedback)*] **TECHNOLOGY** from (D7.2): – Sensor based training system (REHABILITY) – Activity tracker	
Services: **SS2 Agenda**	*Requirement:* **R3-7 Agenda interface** **Context*:*** The user asks the VC to consult the daily agenda of the rehabilitation activities he/she has to carry out. The VC starts the agenda application and shows the daily calendar of the different rehabilitation activities. **Test*:*** - The user asks the VC to consult the daily calendar - The technician verifies the reception of the information by checking the logfiles for the opening of the agenda interface

<u>Test documentation:</u>

Integration:

The test involves the avatar base UI on the tablet and the agenda service (SS2) in the backend which is connected to the KIOLA platform (caregiver UI) providing the rehabilitation schedule via a REST interface. The communication between the UI and the agenda service is performed via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of agenda items by the end-user UI on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity.

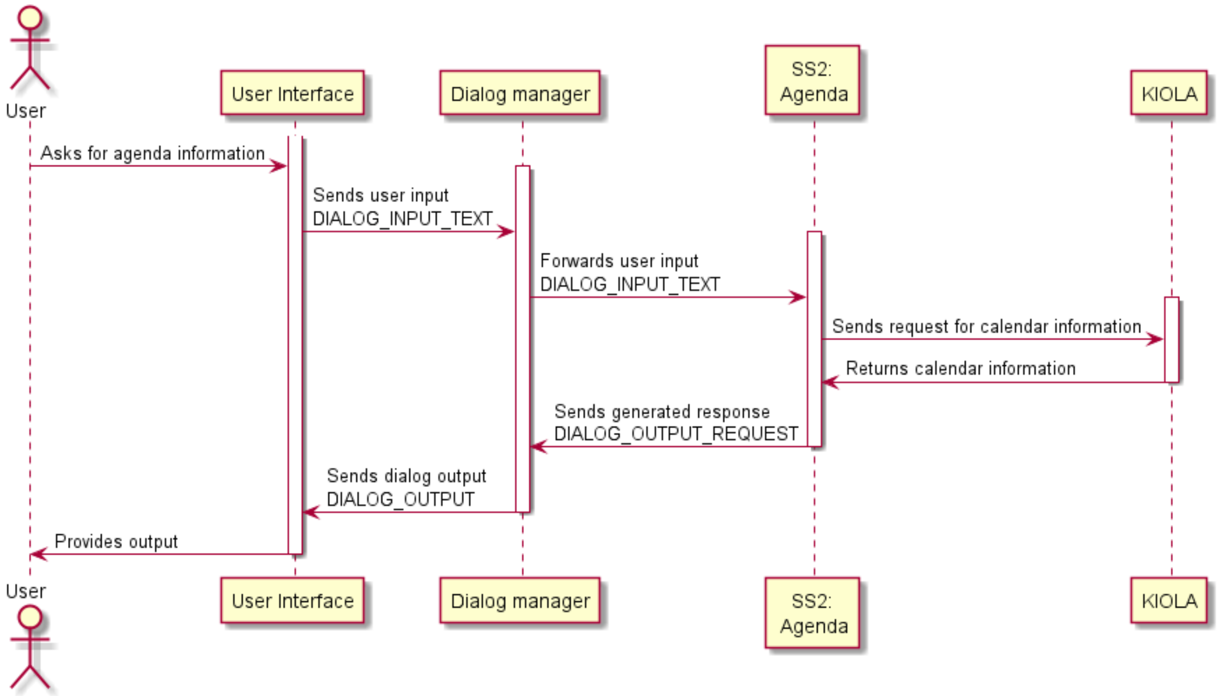

Figure 38: Data flows for test A-1 SD - SS2 - R-3-7

Test execution:

- **Trigger:** speech input at the tablet for asking for the agenda items: "What's on my agenda today". The dialog manger invokes the agenda service, the agenda service requests the agenda items form the care giver UI (KIOLA) and sends them back to the UI.
    - **Integration test:** the message flow through all components was tested.

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
To for this test a speech command "Show me my agenda for today" was stated.	The output is a list of sample agenda items provided by the KIOLA platform provided in JSON format. The list of items is shown on the tablet	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 38 were supervised by technical people by help of the log files.

<table>
<tr><td rowspan="2">Services: SS2 Agenda</td><td>Requirement: R3-1 Coach main interactive application, the avatar</td></tr>
<tr><td>Context:
The user through direct interaction with the avatar asks what upcoming activities are scheduled in his/her agenda for today.
The VC answers

Test:

– Data to simulate the plan of appointments of a daily serious game session for a specific patient are inserted into the system
– The user asks (through the interface) to the VC the activities of a specific day
- The technician verifies that VC answers vocally with a sound message reminding the agenda appointment for that day</td></tr>
</table>

<u>**Test documentation:**</u>

Integration:

The test involves the avatar base UI on the tablet and the agenda service (SS2) in the backend which is connected to the KIOLA platform (caregiver UI) providing the rehabilitation schedule via a REST interface. The communication between the UI and the agenda service is performed via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of agenda items by the end-user UI on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is equal to the message flow of the test A-1 SD – SS2 for requirement R3.7.

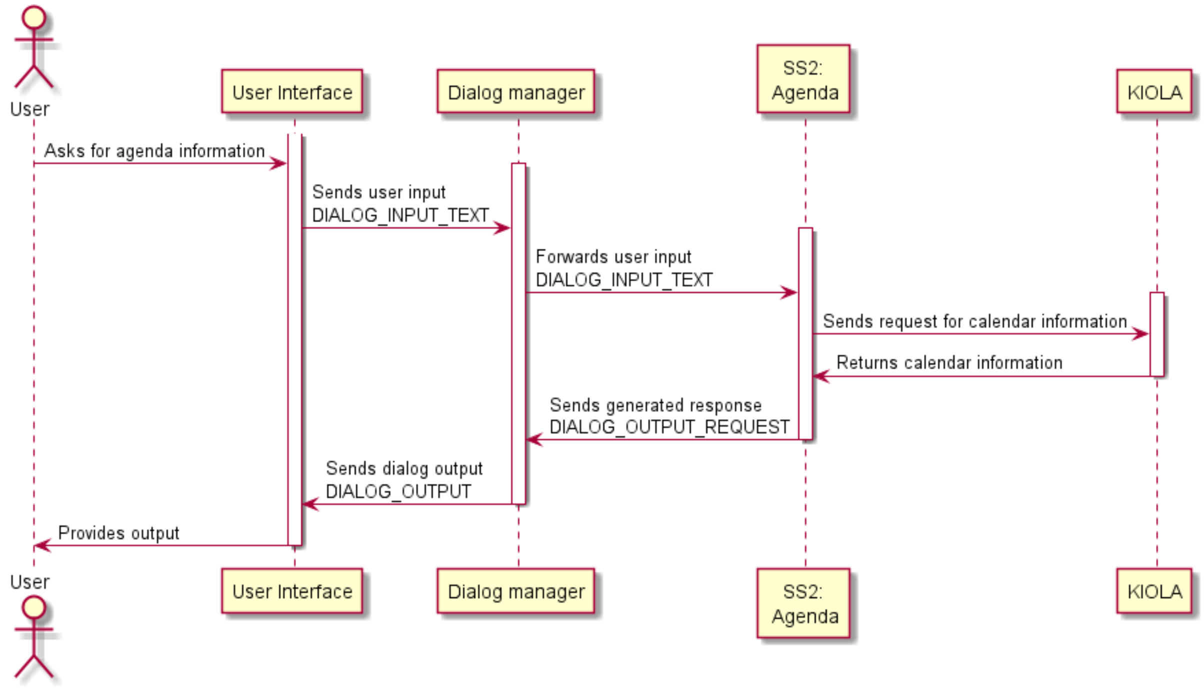

Figure 39: Data flows for test A-1 SD - SS2 – R3-1

Test execution:

- **Trigger:** speech input at the tablet for asking for the agenda items: “What’s on my agenda today”. The dialog manger invokes the agenda service, the agenda service requests the agenda items form the care giver UI (KIOLA) and sends them back to the UI.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** The user command was recognized and the output was provided accordingly using speech and text output modalities.

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
To for this test a speech command “Show me my agenda for today” was stated.	The output is a list of sample agenda items provided by the KIOLA platform provided in	Clinicians are satisfied; the test reflects their expectations.

	JSON format. The list of items is shown on the tablet	

Test summary:
The technical components in an integrated environment at the AIT TechLab is validated. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 39 were supervised by technical people by help of the log files.

Services: **CS5 Rehabilitation coach**	*Requirement:* ***R3-6 Information interface***
	Context: The avatar displays on screen and announce by voice what is the next scheduled activity on the agenda: the motor rehabilitation through the serious games of REHABILITY will start in an hour. **Test:** - The technician verifies in the logfiles that the VC reproduces a reminder due to the scheduling of a serious game session

Test documentation:

Integration:

The test involves the avatar base UI on the tablet, the notification manager service (CS6), die dialog manager and the reasoner. The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of the reminder for a physical training session by the end-user UI on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 40.

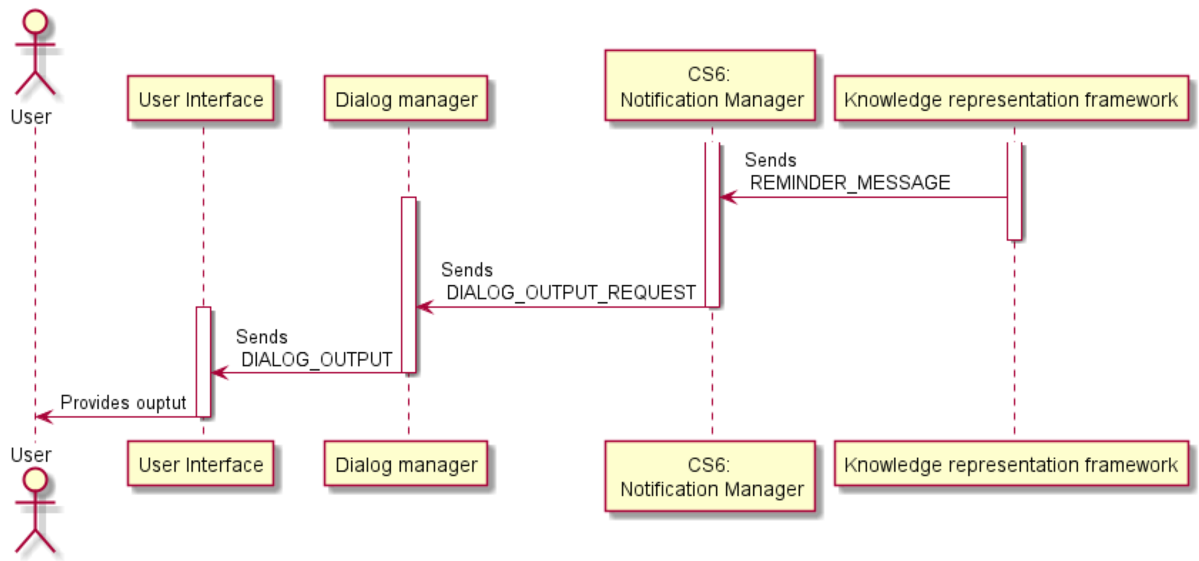

Figure 40: Data flows for test A-1 SD – CS5

Test execution:

- **Trigger:** the reminder is triggered by the Knowledge representation framework manually for the test.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** The reminder has been shown on the tablet via speech output and a textual reminder message.

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
A REMINDER_MESSAGE is triggered manually to be sent via the MQTT broker	At the UI a DIALOG_OUTPUT message is received with the content to be shown to the user	Clinicians are satisfied; the test reflects their expectations. The UI might be a little improved.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the Knowledge representation framework (KRF). The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 40 were supervised by technical people by help of the log files.

Services: **CS6 Intelligent notifications / scheduler**	*Requirement:* ***R2-7 Home inactivity detection***
	Context: The user switches on the TV and Set-Top box. Half an hour (*30 minutes)* has passed by the reminder and the user has not yet started the motor rehabilitation session with serious games. The vCare system recognizes that the user is inactive on the couch and generates through the VC a notification to the user to invite him to go in front of the TV to start his session. **Test:** *(30 minutes is a pseudo realistic time lapse but, in the test, it will be possible to use a shorter time lapse e.g. 5 minutes)* – The user switches on the TV and Set-Top box. – The user does not start the session and waits 5 minutes after the remainder of the scheduled session – 5 minutes of inactivity detected by the system from REHABILITY after the user switched on the TV and Set-Top box – The technician verifies that the time recorded in the database corresponds to 5 minutes. – The technician checks the logfiles to verify that at the 5th minute the VC activates a sound alarm – The user goes then in front of the Kinect – The technician verifies that the user is detected by the Kinect and that the VC states the name of the session to be started

<u>Test documentation</u>

Integration:

The interface to detect inactivity after the Avatar reminds a scheduled activity is tested.

The coaching services detect that the patient has not started the scheduled activity (in this test, a game) after a predefined period (30 minutes but set to 10 seconds for testing) and repeats the reminder.

The interactions are as depicted in the following figure:

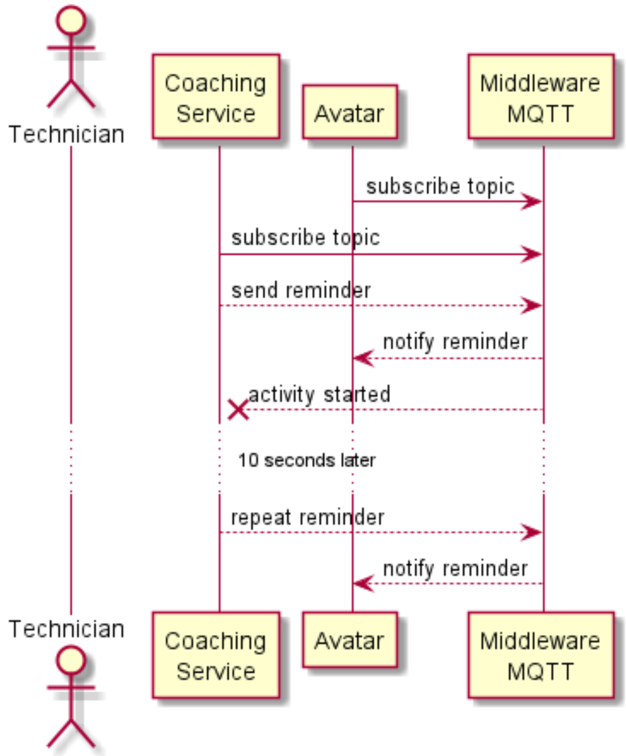

Figure 41: Data flows for test A-1 SD – CS6 – R2-7

Test setup - precondition:

- Technician generates exemplary care plan with activities

Test execution:

- **Integration test**: message with the reminder about the scheduled activity is sent via the middleware.
- **Trigger**: receiving the reminder about a scheduled activity, sent to vcare/<patientId>/reminder/message
- **Coaching service**: after the predefined timeout, the coaching service has not received theGAMEthe GAME_SESSION_STARTED message and repeats the reminder.

Test validation:

- The coaching service subscribes to the GAME_SESSION_STARTED topic
- The coaching service starts a timer which is not cancelled by a message arriving to the GAME_SESSION_STARTED topic.
- The coaching service sends the reminder message a second time

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
Lack of movement in the house is simulated for 5 minutes to feed data to the location service.	The DS1 detects that movement is low in the house ad triggers an 'inactive event' to MQTT.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

This test case proves a specific kind of inactivity related to the patient not reacting to a reminder related to a scheduled game session.

Some of the conditions defined in the test context are not measurable by the vCare system (e.g., detect the patient switches on the TV and the set-top-box).

<table>
<tr><td rowspan="2">Services: CS1
Physical Training</td><td>Requirement: R5-8 Physical training</td></tr>
<tr><td>Context:
The user faces the serious game in standing position as planned by the clinical pathway. The user moves his upper limbs interacting with the motion sensor and feedbacks on screen.

Test:
– The VC begins the serious games session by starting the first two games
– The user plays with the REHABILITY suite at “Popping Flowers” and “Coloured Cans” and reaches a certain score
– The technician verifies that the reached score has been stored correctly into the system</td></tr>
</table>

Test setup - precondition:

- Technician generates exemplary care plan with activities, specifically a game plan including “Popping Flowers” and “Coloured Cans”
- User activates the REHABILITY set top box and start a session

Test execution:

- **Integration test**: message with GAME_SESSION_STARTED topic is sent via the middleware.
- **Trigger**: The user starts a REHABILITY session
- **Coaching service:** message with GAME_RESULT is sent and correctly received:

Test validation:

- Scores are correctly stored in REHABILITY and correctly forwarded to the MQTT broker
- The coaching service receives subscribed topics

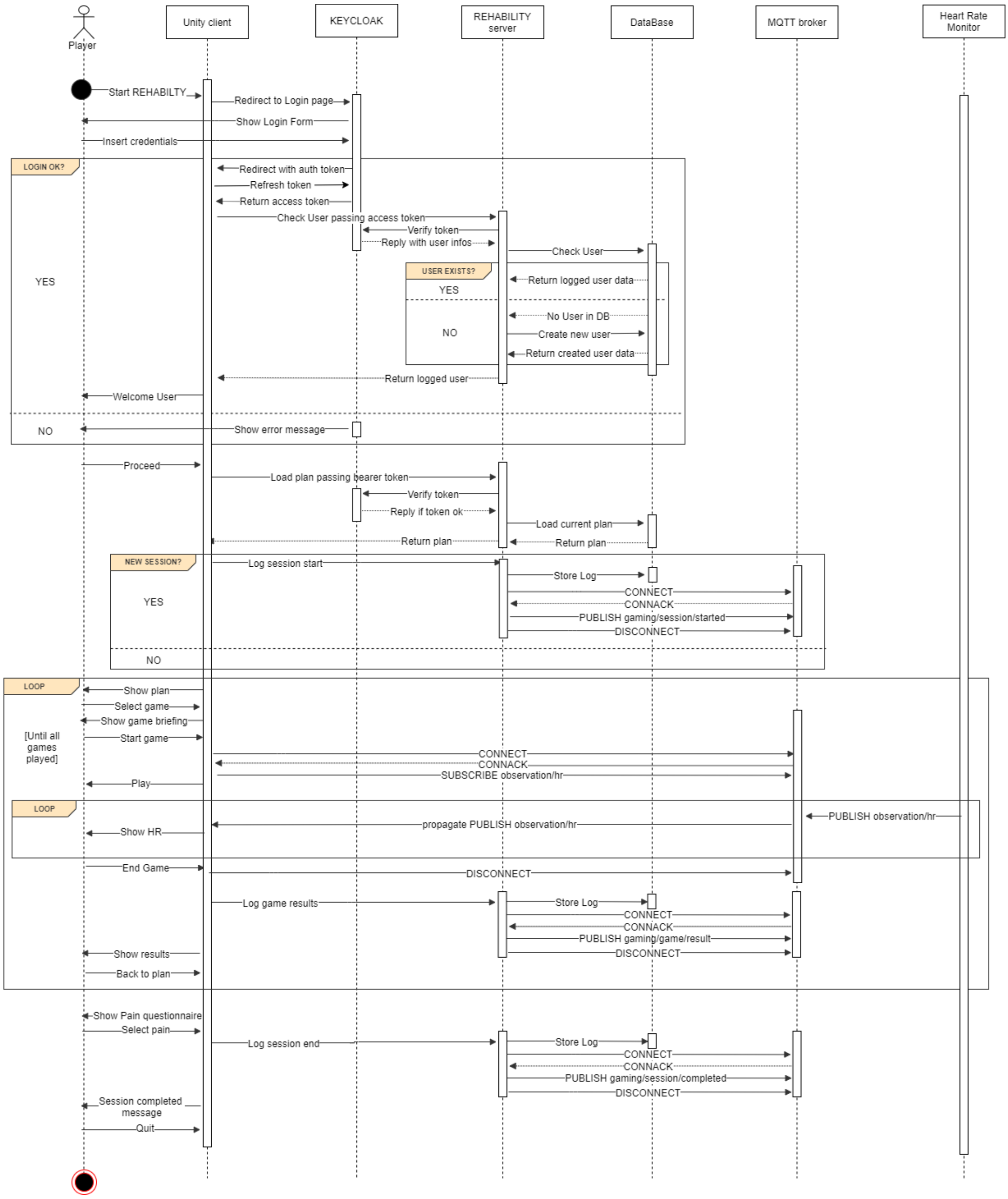

Figure 42: Data flows for test A-1 SD – CS6 – R5-8

Services: **CS5 Rehabilitation coach**	Requirement: ***R4-6 Personalized and context-aware interaction and feedback***
	Context: The user is in front of the TV and has finished the first exercises. The VC gives a feedback about the user's performance. **Test**: - Data to simulate the threshold values related to each game for a specific patient are inserted into the system - The technician verifies that the VC compares the games scores reached in Popping Flowers and *Coloured Cans* with the threshold values and provides the right typology of feedback (see Rules D1.3 pg. 50, [Use Case: UC1 Linked Measure: Game score (to manage Feedback)])

Test documentation:

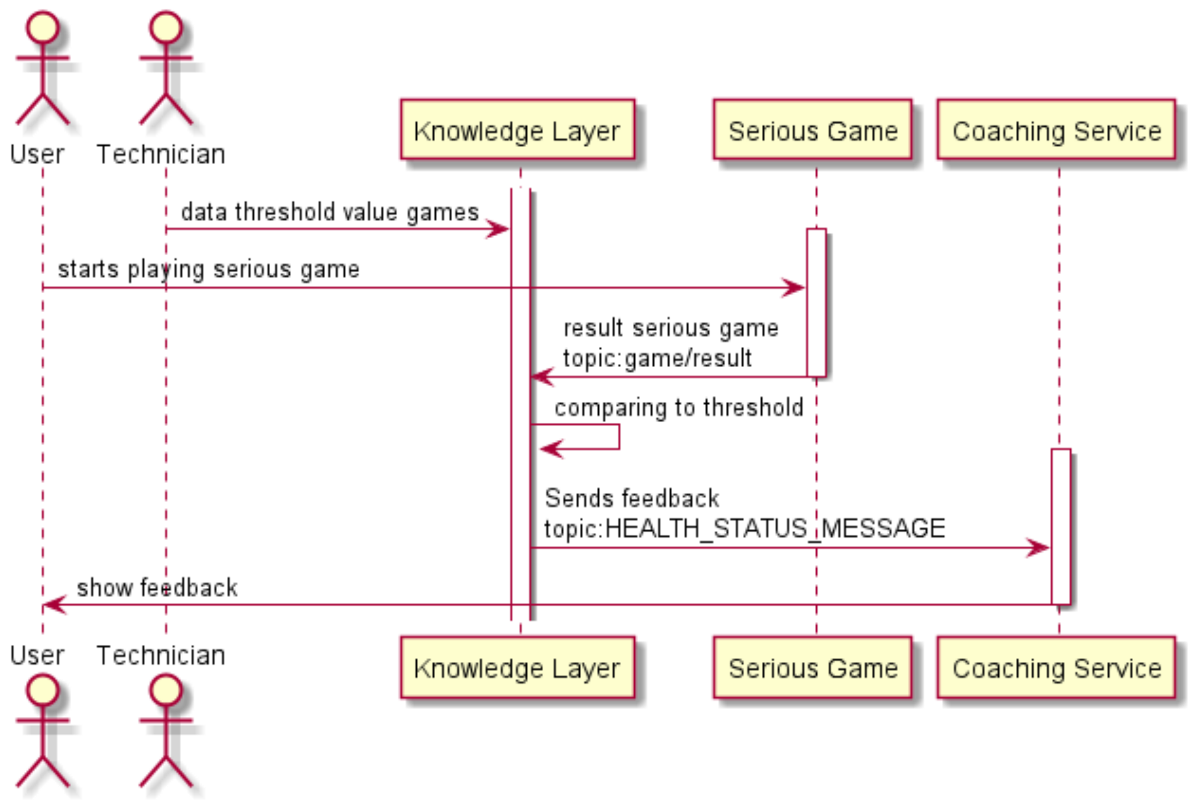

Figure 43: Data flows for test A-1 SD – CS5 – R4-6

Integration:

The interface to integrate the results of serious games played by the patient is implemented, validated and extended. Based on evaluation during TechLab with our technical partners responsible for developing the serious games as well as our medical partners from CCP who we are defining further expert rules with, we are not only storing the score achieved within a serious game but the accuracy and difficulty.

The result of the comparison defined in this use case is triggering the coaching service message to provide a motivation text to the patient, depending on the result achieved.

Test setup - precondition:

While we have the flexibility to perform more complex rules based on the extended information received from our partners, the test defined here only focusses on the score the patient achieved. Therefore, the test setup consists of:

- simulated threshold values related to each game for a specific patient are inserted into the knowledge layer – mapped by game_id and patient_id as defined during TechLab
- technical partner at imaginary plays serious games, where the result messages are connected to the MQTT broker

Test execution:

- **Trigger:** receiving game result message including information about the game score, accuracy received via MQTT broker. Messages are defined based on the ontology **D4.3** and are mapped to the topic of ”vcare/<userId>/gaming/game/result"
    - **Integration test:** messages generated by the end of a serious game played at imaginary are processes via the MQTT broker properly and is stored in the knowledge layer
- game score simulated include all possible relations of score and threshold value. Following configurations were conducted:

Game	score	threshold value
Popping Flowers	[2,10,20,30]	[20]
Coloured Cans	[2,10,20,30]	[20]

Test validation:

- the reasoner compares the games scores reached in Popping Flowers and Coloured Cans with the threshold values
- the reasoner triggers the coaching service messages to provide and "MOTIVATION_TEXT_MESSAGE"

Game	**score**	**threshold value**	**Outcome:** Triggered message	**Rules D1.3** **pg. 50**
Popping Flowers / Coloured Cans	[2]	[20]	Negative	Confirm
	[10]	[20]	motivational	Confirm
	[20]	[20]	Positive	Not defined
	[30]	[20]	positive	confirm

Comment medical partners:

Input summary	**Output summary**	**Comment (Medical Partners)**
We simulate a game Sessions, where we receive the score and compare it to the threshold value. No other parameters or attributes are involved.	If the score is greater than the threshold value, we give positive feedback. If it is below 1/3 of the threshold value, we give motivational feedback.	Based on this basic expert rules more complex scenarios were considered and multi-criteria expert rules defined

Test summary:
We validated the technical components in an integrated environment where partners at Imaginary played a serious game and provided information about the game score to a defined MQTT topic. The information processing within the knowledge layer worked fine as shown in **Test Validation**. Based on the output of the reasoner the according motivational messages in the Coaching Service was triggered. The information was processed automatically and the received resulting motivation message was confirmed by technical partners. Thus, we fulfil the requirements defined in D1.5.
Furthermore, we were able to identify the previously not defined case for expert rules, where the score achieved is exactly the threshold value stored. Related to this test case the TechLab phase has also shown us how to extend the information stored about game results, how to

transfer information via the defined interfaces in MQTT and how to model more complex rules in cooperation with our medical partners.

Services: **DS2 Body position detection**	*Requirement:* ***R2-3 Body position detection***
	Context: The user has finished the first of two games, sits down to rest for a while and when the second game starts user forgets to get back into standing position. As instructed, REHABILITY sensor recognizes his/her wrong posture and sends the user a notification inviting him/her to stand up to continue the serious game in the optimal way. The user gets up and the game can resume. **Test:** – Data simulating the clinical pathway of a specific patient are inserted into the system: the user has to face the serious games in standing position – The user moves an arm while in sitting position – The system records body movements (arm) through REHABILITY sensor – The technician verifies the data accuracy – The system records a wrong posture (sitting instead of standing) – The technician checks the database entries to verify that the system received the information of “arm movement” and “sitting position” from the REHABILITY sensor – The system shows (through a text or audio feedback) the patient how to correct a wrong position/posture (e.g. ‘Extend your arm, try to reach the screen with your hand’) – The technician checks the logfiles to verify that the system alerts the patient with a feedback about how to change the position

Test documentation

Integration:

This test implements an internal validation of the patient body position when exercising. The position check is detected directly by the Rehability game engine through the 3D movement sensor.

The result of this process is to provide guidance to the patient about the correct body position when playing the games.

Test setup - precondition:

- Technician generates exemplary care plan with activities
- Technician triggers the start of a scheduled game

The flow diagram of interactions is as showed in the following figure:

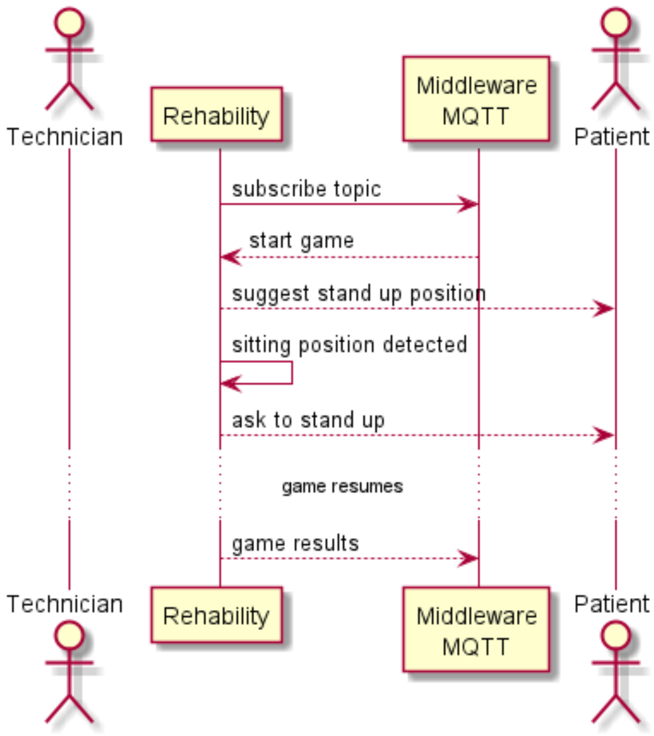

Figure 44: Data flows for test A-1 SD – DS2 – R2-3

Test execution:

- **Trigger**: receiving the message to start the exercise session.
- **Rehability**: suggests a standing position but detects a sitting position.
- **Generated feedback**: the game engine asks the patient to stand up and interrupts the game until this situation is detected.
- When the game finishes, the game engine sends a summary of the activity performed to theGAMEthe GAME_SESSION_PLAYED_RESULTtopicRESULT topic, containing info about the body position during the game.


```
{
    "topic": "vcare\56e39ac5-5ada-4e43-ba35-
af4d6eacd188\gaming\game\result",
    "properties": {
        "USER_ID": "56e39ac5-5ada-4e43-ba35-af4d6eacd188",
        "INTERACTION_ID": "f54fbde4-73f6-4d3f-8b57-fc5785e402f3",
```

```
"TIMESTAMP": 1593505738,
"GAME_ID": 4,
"CONTENT": {
    "vci:GameScore": {
        "score": 250,
        "accuracy": 0.5,
        "correct": 3,
        "wrong": 1,
        "duration": "60",
        "status": "userexit",
        "difficulty": "Level 1",
        "difficulty_id": "64",
        "checks": {
        "spine": {
            "left": {
                "neg": 0,
                "pos": 60.0495948791504
            },
            "right": {
                "neg": 6.87530279159546,
                "pos": 53.1742858886719
            }
        },
        "hand": {
            "neg": 0,
            "pos": 60.0495948791504
```

```
},
"shoulder": {
    "left": {
        "neg": 6.45249176025391,
        "pos": 53.5970916748047
    },
    "right": {
        "neg": 3.75050020217896,
        "pos": 56.2990837097168
    }
},
"position": {
    "standing": {
        "neg": 0,
        "pos": 60.0495948791504
    }
},
"elbow": {
    "neg": 11.0768527984619,
    "pos": 48.9727401733398
}
},
"sequence": {
"name": "Normal",
"id": "14",
"difficulties": [{
```

```
                "name": "Level 1",
                "id": "64"
              }...]
              }
          },
          "game_name": "Popping flowers"
        },
        "SESSION_ID": "28",
        "PLAN_GAME_ID": 44
    }
}
```


Test validation:

- The coaching service subscribes to the GAME_SESSION_STARTED topic
- The coaching service starts a timer which is not cancelled by a message arriving to the GAME_SESSION_STARTED topic.
- The coaching service sends the reminder message a second time

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
A game with position requirements is played.	The game provides guidance to the user on which position to use.	Clinicians are satisfied; the test reflects their expectations. However, during Living Lab Phase many attentions will be focused on guidance feedback to provide to the patients.

Test summary:

This test is an important feature in the game engine, since the benefits from the activities performed in the game are maximized when done in the proper position.

This test cannot be considered as an integration test, since all the logic happens inside Rehability's game engine.

The following figures show the configuration of the game session to add the position check (Figure 45) and the actual tracking of the position done by the game engine (Figure 46)

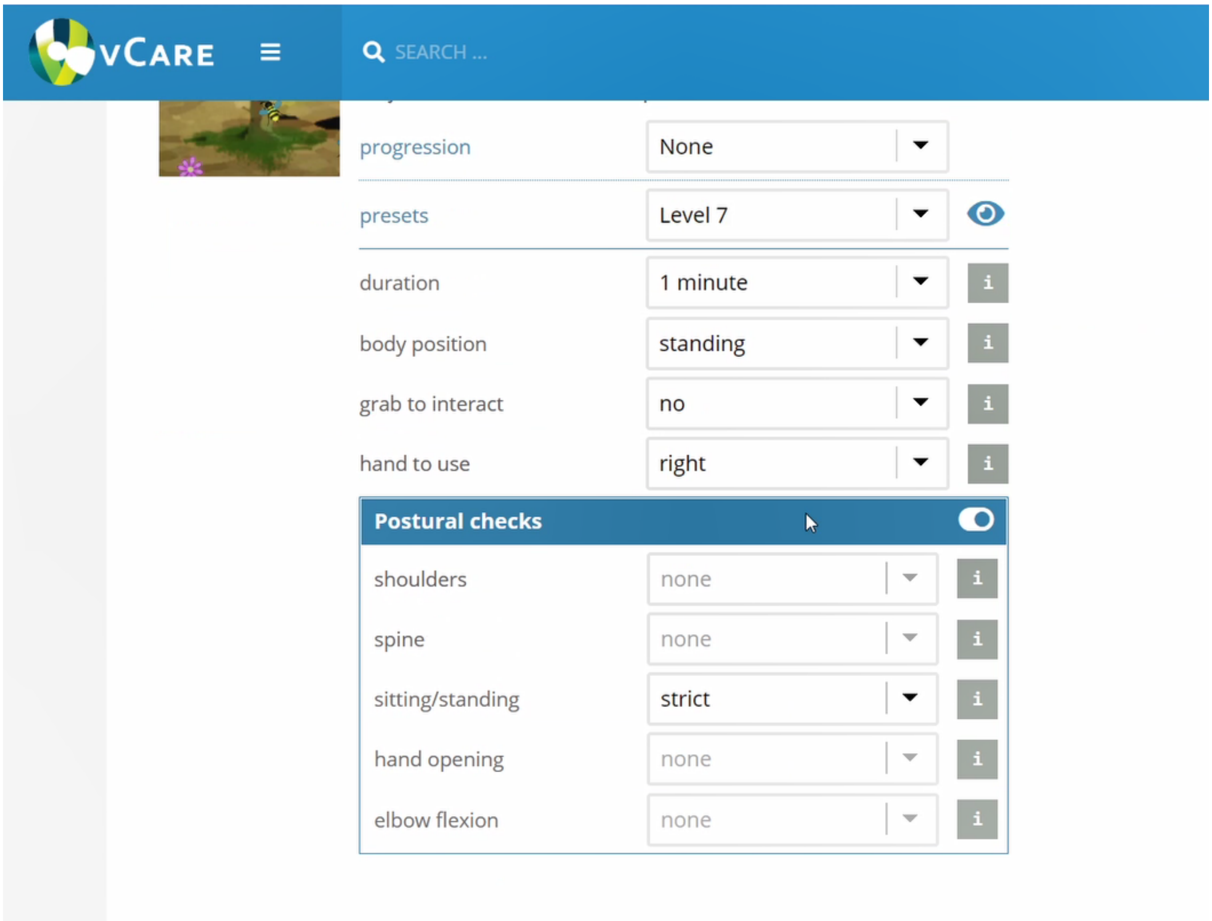

Figure 45: Configuration of a game session to add position check

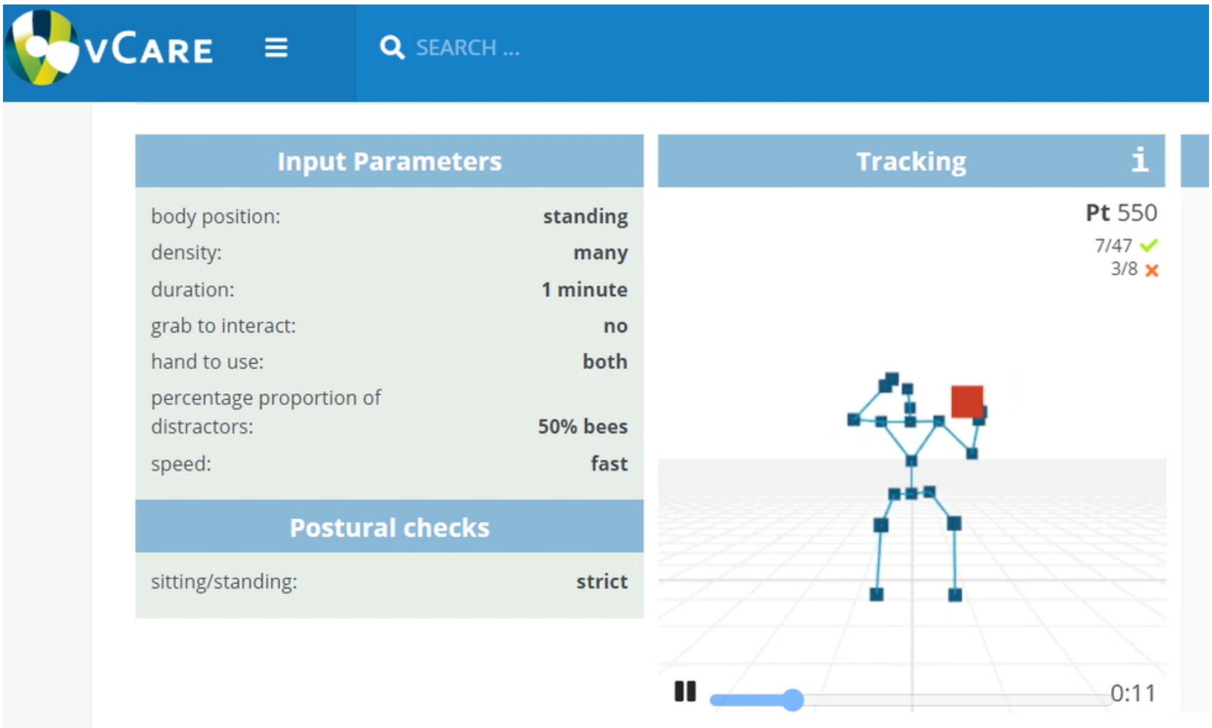

Figure 46: Tracking replay of a game session with postural checks

Services: **CS8 User feeling**	*Requirement:* ***R5-6 User feeling***
	Context: Once serious games session is over, the VC asks the user to report his pain level by showing a VAS scale on the TV screen. The user indicates it and VC stores the information and if necessary, change the activity setup. **Test:** – The technician checks the logfiles to verify that, at the end of the game, the VAS scale appears on the screen and the VC asks to the user to fill in the VAS scale – The user fills in the scale with a value of 8 (high pain) – The technician verifies that the system stored the level of pain indicated by the user by checking the database entries – The technician verifies that the vCare system: stops Serious Game session; Reminds pharmacological therapy; Recommends rest of the joint. (See Rules D1.3 pg. 51, [*Use Case: UC1. Linked Measure: Pain; VAS Scale*])

<u>Test documentation:</u>

Integration:

The test involves the avatar base UI on the tablet, the dialog manager, the knowledge representation framework, and the medical questionnaire service (CS7). The service CS8 is indicated in the definition of the test, is not used because standardised questionnaires as the VAS Pain are all provided by CS7. The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of the questionnaire result by the knowledge representation framework.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 47.

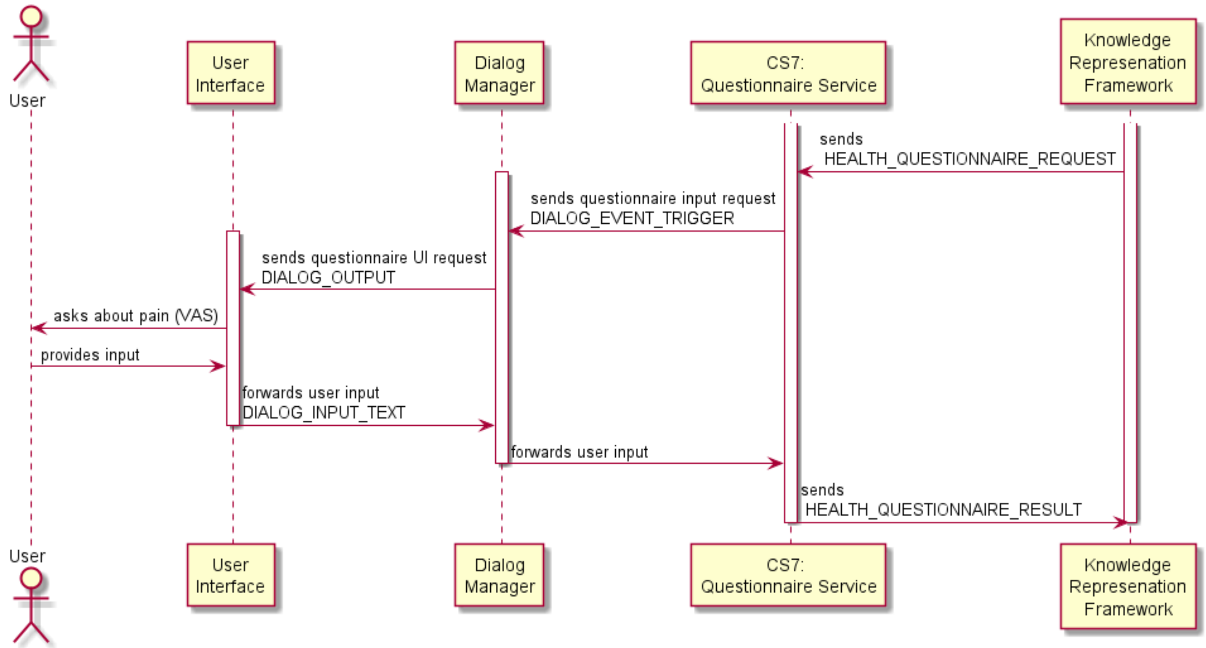

Figure 47: Data flows for test A-1 SD – CS8[12]

Test execution:

- **Trigger**: the KRF simulates the end of a physical game and triggers the VAS pain questionnaire.
    - **Integration test:** the message flow through all components was tested.

---

[12] NOTE: the questionnaires are provided by CS7, hence CS8 does not appear in the diagram, but the name was kept for traceability reasons

- **Interaction test:** The reminder has been shown on the tablet via speech output and a textual reminder message and the response is received by the reasoner (the KRF)

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
A HEALTH_QUESTIONNAIRE_REQUEST message is triggered manually with "VAS-Pain" as content in the QUESTIONNAIRE_TYPE field.	A HEALTH_QUESTIONNAIRE_RESULT message is sent back to the KRF with the data collected from the user	Clinicians are satisfied; the test reflects their expectations. The VAS UI is fine.

Test summary:
We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the Knowledge representation framework. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 47 were supervised by technical people by help of the log files.

<table>
<tr><td rowspan="2">Services: CS2 Health status</td><td>Requirement: R5-5 Health status</td></tr>
<tr><td>Context:
The VC at the end of the session displays the user a game scores report and compares results with the expected goals (predefined by physician) and overall personal best performance.

Test:

– The technician accesses the vCare dashboard and verifies that the system recorded the accomplishment</td></tr>
</table>

<u>**Test documentation:**</u>

Integration:

The test involves the avatar base UI on the tablet, the dialog manager, the knowledge representation framework, the health status service (CS2) and the physical training service (CS1). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving the game session results by the end-user UI on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 48.

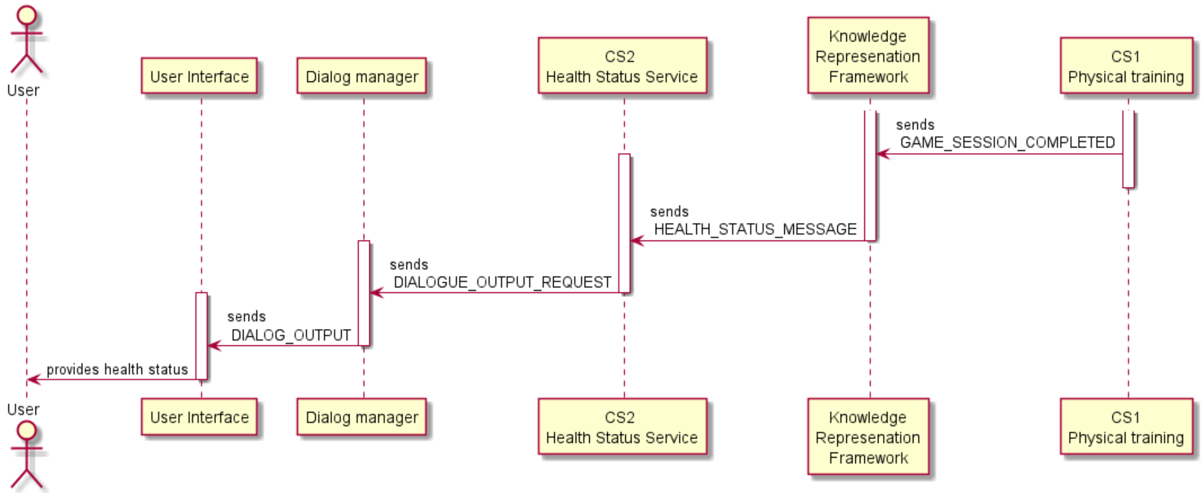

Figure 48: Data flows for test A-1 SD – CS2

Test execution:

- **Trigger**: a technician at IMA triggers the end of a physical training session sending the related MQTT message to the knowledge representation framework. Then, a health status messages is triggered by the Knowledge representation framework providing user and pathway related health status data and the results of the physical game session.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** It is tested if the health status message is shown on the UI.

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
A GAME_SESSION_ENDED message is triggered manually to be sent to the reasoner	The UI receives the data of the exergame performance via the DIALOG_OUTPUT message	Clinicians are satisfied; the test reflects their expectations. The content of the “game session results” could be a little improved.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the Knowledge representation framework and IMA providing the CS1. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 48 were supervised by technical people by help of the log files.

7.1.2 Test report Activity A-2 SD: Coaching for an active lifestyle

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Location + activity monitoring	DS-1	R2-1, R2-6, R2-7
Weather	SS-1	R3-10
Health status	CS-2	R5-5
Rehabilitation coach	CS-5	R3-6, R4,6
Intelligent notifications scheduler	CS-6	R2-7, R2-8, R3-1, R3-6, R5-3, R5-4
User Feeling	CS-8	R5-6
Detection of activities of daily living	DS-7	R2-8, R2-9
Standby	SS-3	R3-11

Test case

Activity: COACHING FOR AN ACTIVE LIFESTYLE
Initial setting (from D1.3) As part of the First narrative/Use Case #1, Maria profile’s at discharge from the hospital composed by **ONTOLOGY** (from D1.3/D4.2): – “**Patient profile**”: pathology (e.g. stroke), clinical data depicting the clinical syndrome

<table>
<tr><td colspan="2">
– “Evidence Indicators”: time of inactivity, number of steps, activity duration
– “Activity”: outdoors physical activities
– “Time Event”: free (no predefined schedule)
– “Assessment Documents”: the VC system sends a concise report (document) to the physician

REASONER (from D1.3):

– monitoring of indoor motor activity (walking) (Rules D1.3 pg. 50, [Use Case: UC1 Linked Measure:number of steps]
– monitoring of indoor motor activity (Rules D1.3 pg. 50, [Use Case: UC1 Linked Measure: Time of Inactivity [min]]

TECHNOLOGY from (D7.2):

– Activity tracker
– Presence sensor
</td></tr>
<tr><td rowspan="2">Services: DS-1
Location of the patient in the house and home activity/inactivity monitoring</td>
<td>Requirement: R2-7 Home inactivity detection</td></tr>
<tr><td>Context:
VC detects that the user has been inactive today for 4 hours

Test:
(4 hours is a pseudo realistic time lapse but, in the test, it will be possible to use a shorter time lapse e.g. 5 minutes)

- The VC detects that the user has not been moving much around the house during the previous 5 minutes and did not go out either
- The activity tracker is not giving ‘active’ levels for 5 minutes
- The technician verifies the accuracy of data sent via Bluetooth from the activity tracker sensor
- The technician checks the database entries to verify that the time of inactivity recorded corresponds to 5 minutes
</td></tr>
</table>

Test documentation

Integration:

This involves the Smart Home system and the detection of location of the patient in the house. The service can also consume data from the activity tracker to provide a more accurate detection but depends on the availability of connection with the tracker device.

Test setup - precondition:

We assume that we are monitoring the user during the day hours (e.g., 8AM to 19PM). The algorithm takes into account the quantity of movement around the house and the data from the activity tracker (number of steps). The activity is measured using a moving average window of 4 hours (in the test, reduced to 5 minutes for simplicity).

The expected outcome is an event suggesting inactivity during the measured interval.

The message flows are as depicted in the Figure 46.

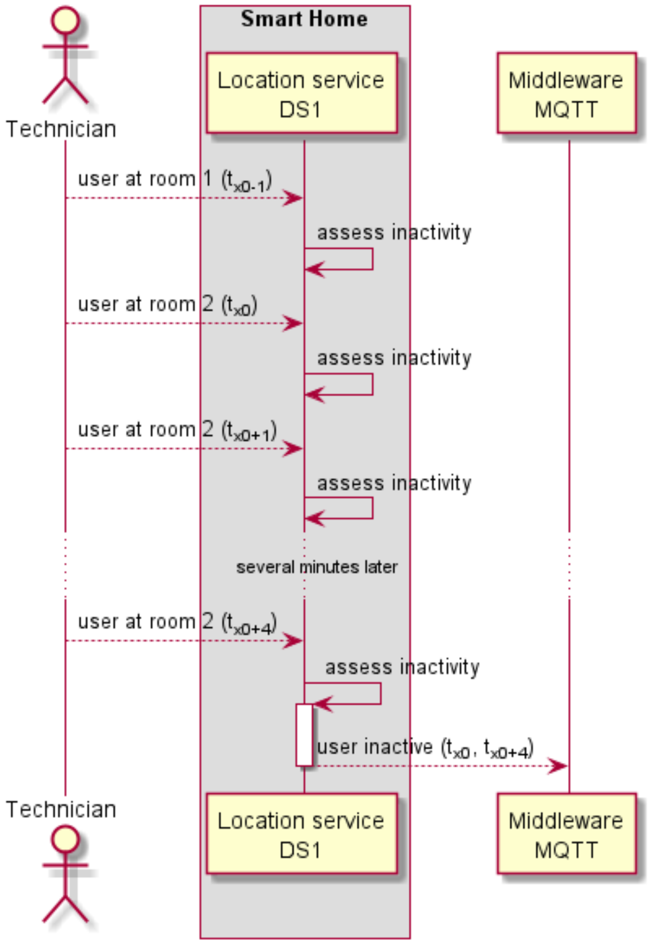

Figure 49: Data flows for test A-2 SD – DS1 – R2-7

Test execution:

- **Trigger**: technician feeds location data with temporal marks spanning 5 minutes. The location is not changed during the 5 minutes
- **Integration test**: message flow between components is verified. Correct execution of the inactivity assessment is checked.

Test validation:

The DS7 is generating a message to the topic observation topic observation/daily_activity with activity with contents:

```
{
  "topic": "vcare/${patientId}/observation/daily_activity",
```

```
  "properties": {
      "INTERACTION_ID": "...",
      "TIMESTAMP": "0",
      "USER_ID": "${patientId}",
      "CONTENT": {
          "@context": {
              "vcs": "http://ontology.vcare-
project.eu/vcare_ontology_schema.ttl#",
              "vci": "http://ontology.vcare-
project.eu/vcare_ontology_instances.ttl#",
              "rdf":"http://www.w3.org/TR/rdf-syntax-grammar#",
              "saref":"https://w3id.org/saref#"
          },
           "vcs:dailyActivity": {
              "type": "vci:inactive",
              "timestamp": "2020-07-03T09:43:07Z ",
              "vcs:timeInactivity":{
                "rdf:value":5,
                "saref:hasUnit":"minutes"
              }
          }
      }
  }
}
```

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
Lack of movement in the house is simulated for 5 minutes to feed data to the location service.	The DS1 detects that movement is low in the house ad triggers an 'inactive event' to MQTT.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated that, after the right preconditions, the DS1 service is able to detect that there is no movement in the home and generates an event to notify vCare system.

Services: **CS-8 User feeling**	*Requirement:* ***R5-6 User feelings***
	Context: The user is sitting on the couch without doing anything. VC asks questions to the user regarding its subjective wellbeing, scoring with a 5-points Liker scale. **Test:** - The technician verifies that the VC asks the subjective user's wellbeing scoring it on a 5-point Likert scale. - The user answers - The technician checks the database to verify that the saved score corresponds to the number indicated by the user

Test documentation:

Integration:

The test involves the avatar base UI on the tablet, the dialog manager, the knowledge representation framework, the user feeling service (CS2), and the questionnaire service (CS7). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of agenda items by the end-user UI on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 50.

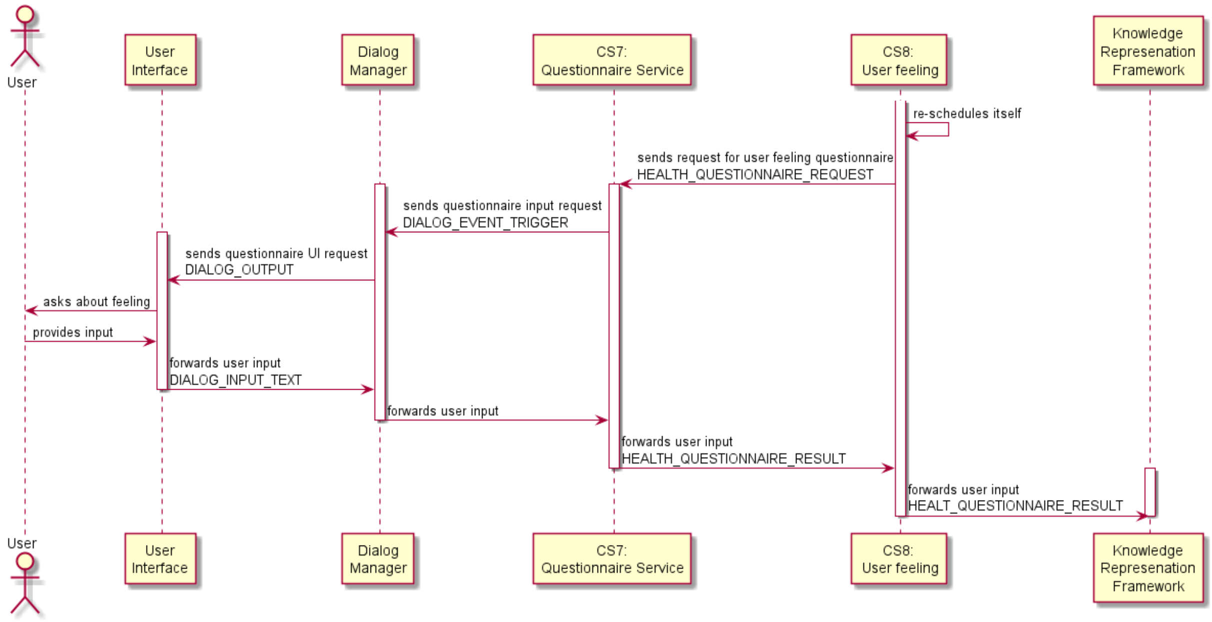

Figure 50: Data flows for test A-2 SD – CS8

Test execution:

- **Trigger**: the user feeling service is triggered manually at this stage to invoke the well-being questionnaire. Later, it will be triggered by the reasoner in dependence of the context (inactivity / presence) of the user). The related questionnaire is shown on the UI and the answer of the user is send back and forwarded to the Knowledge representation framework.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** It is tested if the health status message is shown on the UI and the answer is sent back to the KRF.

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
The CS8 service is triggered manually to invoke the well-being questionnaire. Then, the questionnaire service is triggered to load the appropriate questionnaire from the	A HEALTH_QUESTIONNAIRE_RESULT message is sent back to the reasoner	Clinicians are satisfied; the test reflects their expectations. The UI is fine.

LimeSurvey database and
provide it to the UI

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the Knowledge representation framework. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 50 were supervised by technical people by help of the log files.

Services: **DS-7 Detection of activities of daily living**	*Requirement:* ***R2-8 Home behaviour monitoring***
	Context: The VC rebuilding the user's habits recognizes that usually in the afternoon the user leaves the house for a walk. **Test:** - Data simulating the usual user behaviour are inserted into the system: in the afternoon (between 3 pm and 6 pm) the user leaves for a walk - The technician verifies that the VC provides information about usual patient behaviour and habits at this time

Test documentation

Integration:

This involves the Smart Home system and the detection of daily activities service (DS7). The communication between both components is established via the MQTT broker. The components are implemented, and the communication channels are setup. The result is an event published to the MQTT broker detecting a deviating behaviour.

Test setup - precondition:

At this stage, location events from sensors is simulated to cover a period of 3 hours (between 3 and 6 PM). A behaviour profile is created in the DS7 to indicate the patient usually goes out in that time frame.

The message flows are as depicted in the figure below.

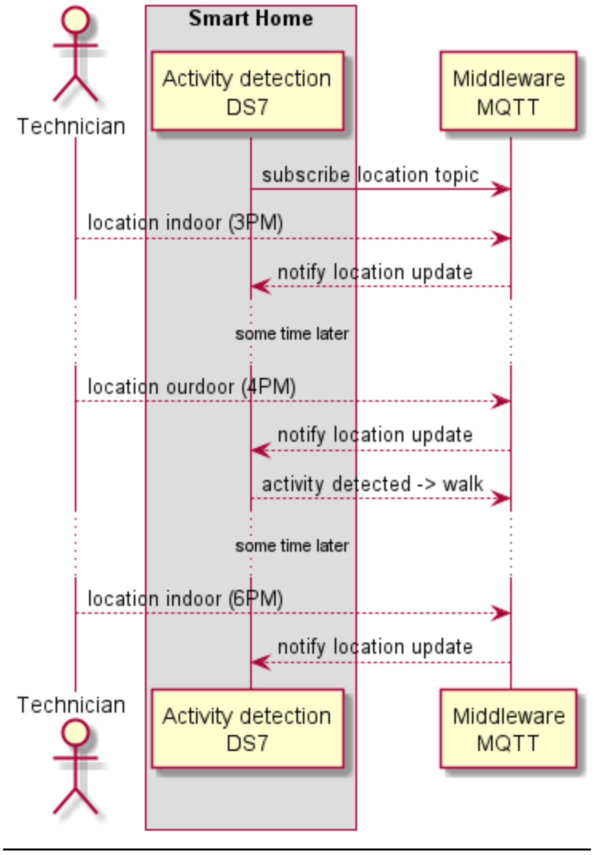

Figure 51: Data flows for test A-2 SD – DS7 – R2-8

Test execution:

- **Trigger**: the DS7 execution is triggered manually to analyse data daily activities at 12PM.
- **Integration test**: message flow between components is verified.

Test validation:

The DS7 is generating a message to the topic `observation/daily_activitty` with contents:

```
{

  "topic": "vcare/${patientId}/observation/daily_activitty",

  "properties": {

      "INTERACTION_ID": "abcde",

      "TIMESTAMP": "0",

      "USER_ID": "${patientId}",
```

```
      "CONTENT": {
          "@context": {
              "vcs": "http://ontology.vcare-
project.eu/vcare_ontology_schema.ttl#",
              "vci": "http://ontology.vcare-
project.eu/vcare_ontology_instances.ttl#"
          },
          "vcs:DailyActivity": {
              "value": "vci:Walking",
              "timeStamp": "2020-07-02T04:05:00Z ",
              "totalSteps": 1234
          }
      }
  }
}
```


Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
Movement in the house is simulated between 10AM and noon.	The DS7 detects a deviating behaviour and publishes an event to a specific topic	Clinicians are satisfied; the test reflects their expectations. However, during Living Lab Phase many attentions will be focused on information to provide to the patients.

Test summary:

We validated the technical elements in a lab environment that the daily activity monitoring service can detect that the user goes out for a walk at the defined time frames.

Services: **SS-1 Weather**	*Requirement:* ***R3-10 Weather info***
	Context: The user asks the VC about current weather conditions. The VC checks weather forecasts. **Test:** - The user asks the VC about current weather - The technician checks the logfiles to verify that at a certain time the VC stores information about the current weather and informs the user.

Test documentation:

Integration:

The test involves the avatar base UI on the tablet and the weather service (SS1) in the backend. The communication between the UI and the agenda service is performed via the MQTT protocol using the vCare MQTT broker. The third-party API is connected via a REST interface. All components have been implemented and all communication channels are set up and the message flow is depicted in Figure 52 below. The result of the test is the receiving of the weather information on the UI on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been defined and implemented. The service is connected to the third-party weather data provider via a REST API which is provided the current weather data.

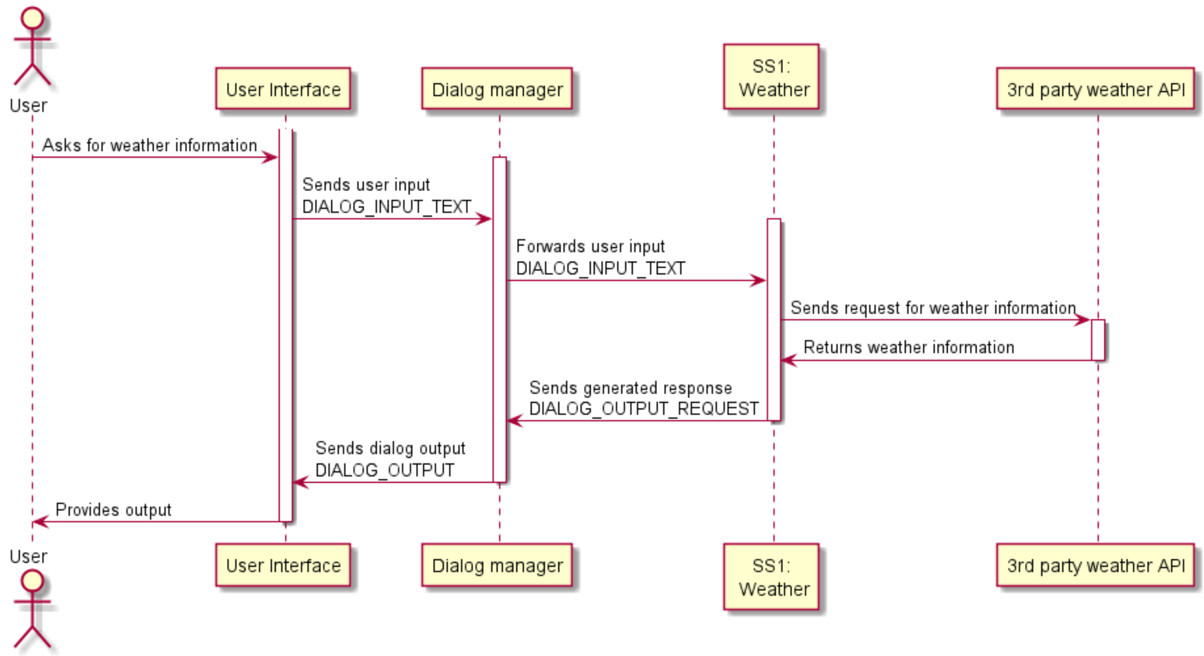

Figure 52: Data flows for test A-2 SD – SS1

Test execution:

- **Trigger:** speech input at the tablet for asking for the agenda items: "What is the weather today?". The dialog manger invokes the weather service and sends back the related information to the UI
  - **Integration test:** the message flow through all components was tested.
  - **Interaction test:** the weather information is presented via the UI.

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
The test is triggered verbally with the "What is the weather for today?" command.	The forecast for today's weather is then provided via speech output on the tablet.	Clinicians are satisfied; the test reflects their expectations. The introduce a graphical display of forecast could help but it is not strictly necessary

Test summary:
We validated the technical components in an integrated environment at the AIT TechLab. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 52 were supervised by technical people by help of the log files.

Services: **CS5 Rehabilitation coach**	*Requirement*: ***R4-6 Personalized and context-aware interaction and feedback***
	Context: The VC, considering the daily state of physical inactivity of the user protracted for a long time (personal state), considering the good weather (environment profile), considering the user's compliance (personal state & historical information), considering the user's health status (clinical state), and considering the reconstruction of his afternoon habits (clinical pathway profile), proposes a physical activity among those available in the clinical pathway (activity profile & clinical pathway profile): a walk outside in the open air at a pace of 5km/h for 30 minutes. **Test:** - The technician verifies that the system stores the information of “High level of user inactivity”, “favourable weather forecast”, “usual walk outside” and “adequate clinical state”. - The technician checks the logfiles to verify that IF high level of user inactivity AND favourable weather forecast AND usual walk outside AND adequate clinical state, THEN the VC proposes the *coaching for an active lifestyle activity*: “walking outdoor at 6km/h for 30 minutes”

<u>Test documentation:</u>

Integration:

The interface to integrate the personal and clinical state for a patient is defined and validated. This information lay ground to the personalisation of an individual care plan. Extending the information stored in the knowledge layer to also hold an environmental profile (as defined in **D4.3** and finalised in **D4.4**) we can extract this information from our RDF-files in the triple store.

After processing the information stored in the reasoner according to the definition in the use case the framework then proposes a new scheduled activity to be added to the patients care plan for this day.

The result of this process is the modification of an individual care plan by adding a new scheduled activity (as defined in **D6.4**) to the care plan. Since this technical component is validated in an integrated environment the information is provided to the central middle ware server via the MQTT broker to the topic "vcare/<<patientId>>/careplan/modified".

Test setup - precondition:

- Technical partners generate exemplary clinical state attributes of a patient
- Integration tests on processing the state attributes of a patient

- Simulated knowledge input about the weather and habits inserted to the knowledge layers RDF-store
- Integrated tests on proposing activity

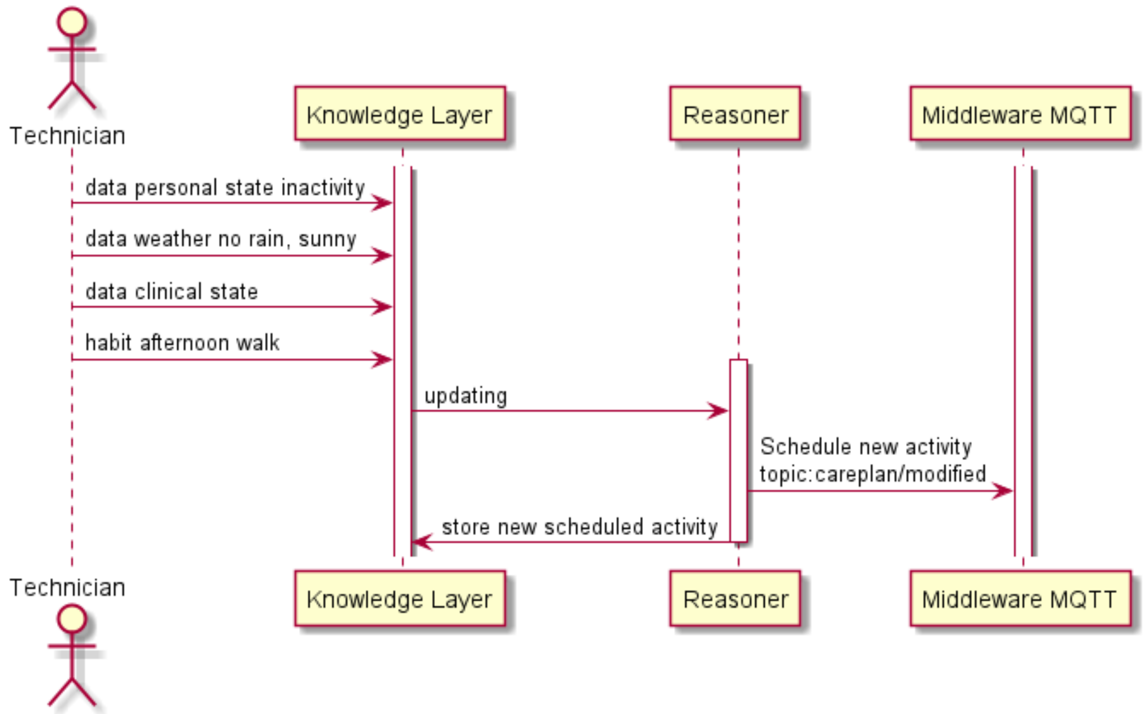

Figure 53: Data flows for test A-2 SD – CS5 - R4-6

Adjustments and Specifications during TechLab with medical partners from CCP:

Favourable weather forecast:

- NO RAIN
- NO ICE
- NO FOGG (to avoid visibility problems)
- NO dark hours (1 hour after sunrise and 1 hour before sunset) (to avoid visibility problems)
- temperature < 30°C

The "**adequate clinical state**" is defined by the ROM, MiniBest and current Borg. Walking can be proposed **IF** [all (ROM hip) are medium OR high

AND all (ROM knee) medium OR high

AND all (ROM ankle) medium OR high

AND (MiniBest) is high

AND (current Borg) is medium OR low

Test execution:

- **Integration test:** messages holding information about different clinical state parameters are processes via the MQTT broker properly and are stored in the knowledge layer
- **Trigger:** receiving messages about a patient inactivity via MQTT broker. Message to the topic of "vcare/<patientid>/observation"
- **Reasoner:** automatically checks if all three conditions (see further specifications during TechLab in section **Comment medical partners**)
- Proposes walking for 30 min at a pace of 6 km/h as a new scheduled activity to the broker

Test validation:

- the reasoner compares the current state of the patient received by the MQTT broker to the threshold values defined by our medical partners
- the reasoner generates a new scheduled activity as defined in the ontology (**D4.3**) and provides these information to the topic of the patient's individual care plan

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
to test this use case, we simulate a patient and store information about a simulated agenda in our knowledge graph. We also insert information about the patients habit of walking outside, that would be extracted as a pattern in the long run.	VC proposes the coaching for an active lifestyle activity: "walking outdoor at 6km/h for 30 minutes"	For a first test this condition is correct. Complex conditions defined in TechLab to be continued.

Test summary:

Basis for the test execution defined here was the extensive specification of the mentioned input conditions. In exchange with the medical experts, it was possible to define not only the requirements for this exact use case, but also the basic rules that are used for suggesting activities in our Smart Agent.

In addition to these content-related achievements, we were also able to test and validate the integration of the relevant components. Both the recording of clinical conditions of the patient and the provision of information about a new planned activity could be achieved in cooperation with the respective technical partners.

Services: **CS6 Intelligent notifications/scheduler**	*Requirement:* ***R3-1 Coach main interactive application, the avatar***
	Context: The VC proposes to the user a walking route at 6km/h for 30 minutes. The user accepts. **Test:** - The reasoner selects and proposes a walk outside in the open air at 6km/h for 30 minutes. - The user accepts the proposal - The technician checks the database entries for the storage of the positive answer

<u>Test documentation:</u>

Integration:

The test involves the avatar base UI on the tablet, the notification manager service (CS6), die dialog manager and the reasoner (the KRF). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of the reminder for a physical training session by the end-user UI and the receiving of the response by the reasoner which stores it in the database.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 54.

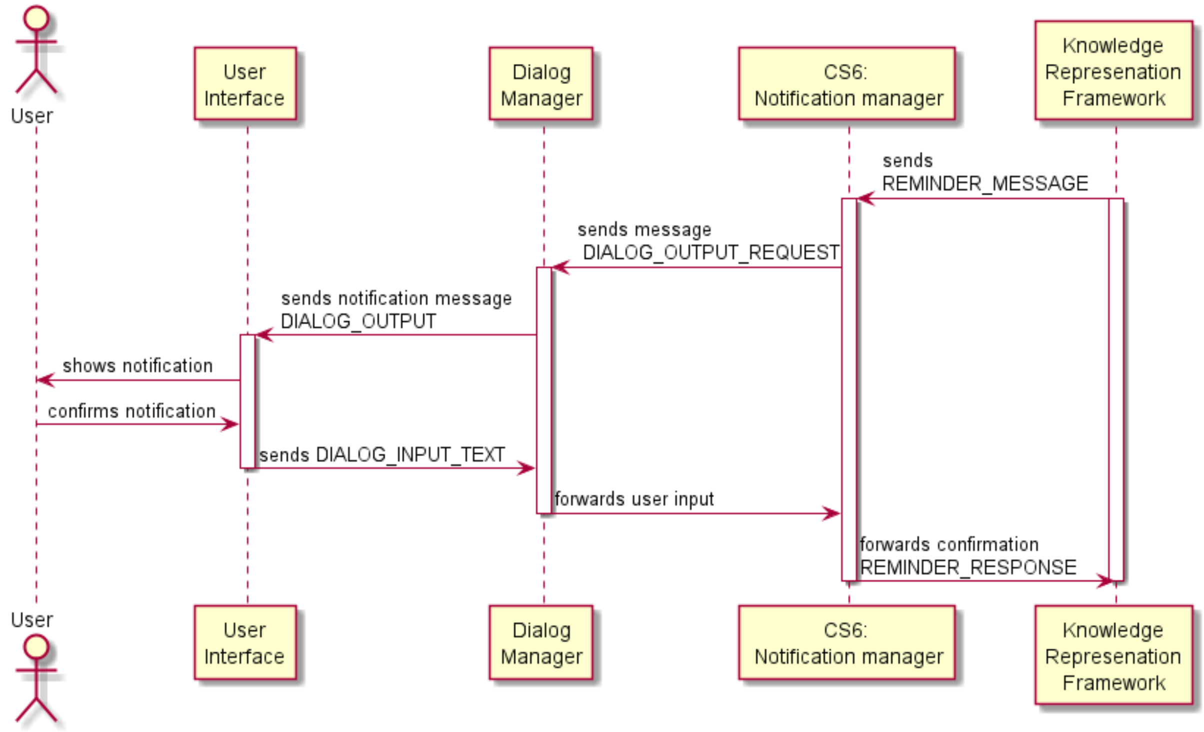

Figure 54: Data flows for test A-2 SD – CS6

Test execution:

- **Trigger:** the reminder is triggered by the Knowledge representation framework manually for the test.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** The reminder has been shown on the tablet via speech output and a textual reminder message and the user can confirm the proposal

Test validation:

- The log of the end-user UI is checked if the response could be received.
- The KRF is checked if the response has been received

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
A REMINDER_MESSAGE is triggered manually with the confirmation option (Yes | No | Remind me later) by the user.	The response of the message is sent back to the user as REMINDER_RESPONSE message	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the Knowledge representation framework. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 54 were supervised by technical people by help of the log files.

Services: **CS6 Intelligent notifications/scheduler**	*Requirement*: ***R3-6 Information interface***
	Context: According to the user's clinical pathway, the VC reminds the user to wear appropriate footwear and not to forget his cane. **Test:** - Data simulating the clinical pathway of the user are inserted into the system: the user has to use a cane - The technician checks the logfiles to verify that IF the user is going out for a walk AND IF he needs a walking aid, THEN the Virtual Coach synthesizes an audio reminder: "wear suitable footwear and do not forget the walking aid".

<u>Test documentation:</u>

Integration:

The test involves the avatar base UI on the tablet, the notification manager service (CS6), die dialog manager and the reasoner. The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of the reminder for using the walking aid.

Test setup - precondition:

Data simulating current prescription of the user in terms of using a walking aid are manually added into the knowledge layer. Based on the defined expert rule the reasoner triggers the according message.

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 55.

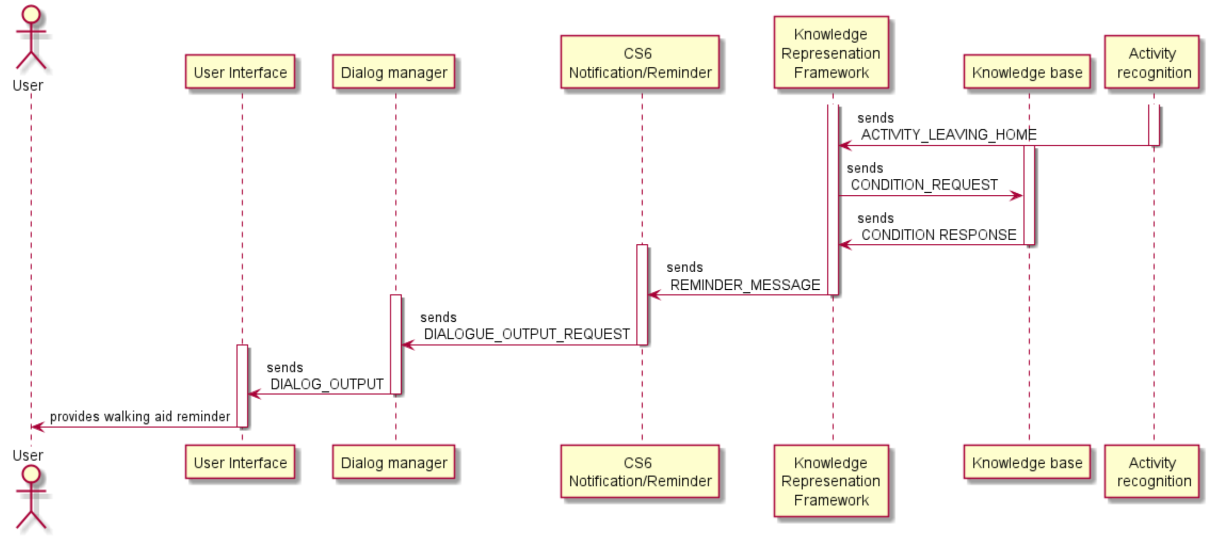

Figure 55: Data flows for test A-2 SD –CS6

Test execution:

- **Trigger:** the reminder is triggered by the KRF based on the manual trigger “leaving home context”
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** The reminder has been shown on the tablet via speech output and a textual reminder message.

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
A REMINDER_MESSAGE is triggered manually by the KRF	The output is the content of the reminder message presented in textual and verbal form.	Clinicians are satisfied; the test reflects their expectations.

Test summary:
We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 55 were supervised by technician by help of the log files.

Services: **DS-1 Location of the patient in the house and home activity/inactivity monitoring**	*Requirement*: ***R2-6 Activity monitoring***
	Context: The VC keeps track of physical activity during the walk by counting the number of steps. **Test:** - The user wears the activity tracker and walks for 2 minutes - The technician verifies that the activity tracker activates the daily step counter when the user starts walking and stores the number of steps performed by the user during a 2-minutes' walk - The technician checks the database entries to verify that the number of steps stored into the system corresponds to the number of steps performed by the user

<u>Test documentation</u>

Integration:

This test uses the DS1, Location and home activity monitoring, to scan for data published by the activity tracker, via a mobile app, to the MQTT broker.

The step count value might not be available at all times since a mobile app is required to connect to the device and extract the information. In a more realistic scenario, this info will be transmitted sporadically throughout the day.

Test setup - precondition:

We assume that the DS1 is subscribed to receive data from the activity tracker. The technician opens the app and it gathers the data and publishes to the 'step_count' topic in MQTT.

The message flows are as depicted in the Figure 53.

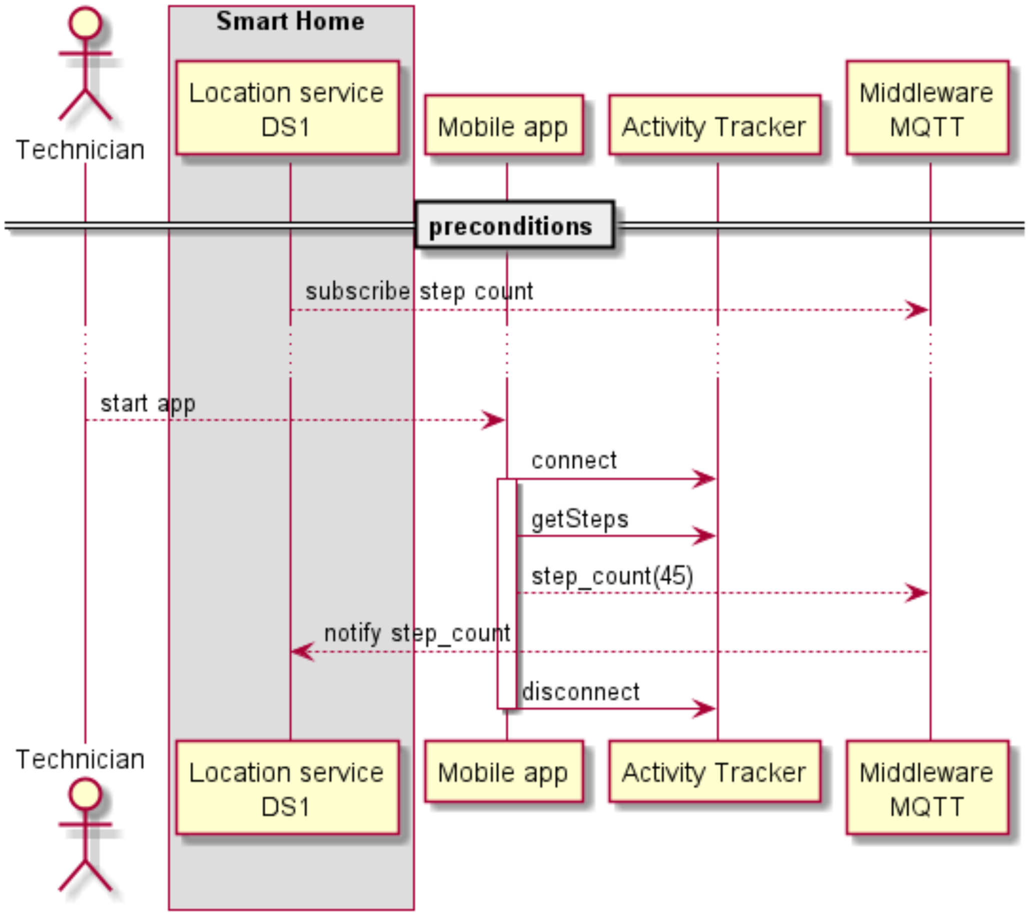

Figure 56: Data flows for test A-2 SD –DS1 - R2-6

Test execution:

- **Trigger**: starts the mobile app, which automatically connects to the activity tracker
- **Integration test**: the app retrieves the step count value and publishes it to MQTT

Test validation:

- The DS7 is generating a message to the topic observation/number_of_steps with contents:


```
{
  "topic": "vcare/${patientId}/observation/number_of_steps",
  "properties": {
      "INTERACTION_ID": "abcde",
      "TIMESTAMP": "0",
```

```
        "USER_ID": "${patientId}",
        "CONTENT": {
            "@context": {
                "vcs": "ontology.vcare-project.eu/vcare_ontology.ttl#"
            },
            "vcs:numberOfSteps": {
                "value": "35",
                "timestamp": "2020-07-03T09:05:00Z",
            }
        }
    }
}
```


Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
Lack of movement in the house is simulated during 5 minutes to feed data to the location service.	The DS1 detects that movement is low in the house ad triggers an 'inactive event' to MQTT.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated that, after the right preconditions, the DS1 service is able to detect that there is little movement in the home and generates an event to notify vCare system.

<table>
<tr><td rowspan="2">Services: CS2 Health status</td><td>Requirement: R5-5 Health status</td></tr>
<tr><td>Context:
When the user goes back home, the VC provides the report of the physical activity just performed (number of steps, time of physical activity).

Test:
– The user asks the VC to see the report of current activity</td></tr>
</table>

	– The technician checks the logfiles to verify that the Virtual Coach generates a report of current activity – The user accesses to the activities dashboard and verify the number of steps, time of physical activity and route covered.

<u>Test documentation:</u>

Integration:

The test involves the avatar base UI on the tablet, the dialog manager, the KRF, the health status service (CS2) and the Motivational message framework of CS5. The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving the health status on request by the user on the UI running on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. For this test, the data of the current activity are entered into the system manually. The message flow for this test is depicted in Figure 57 below.

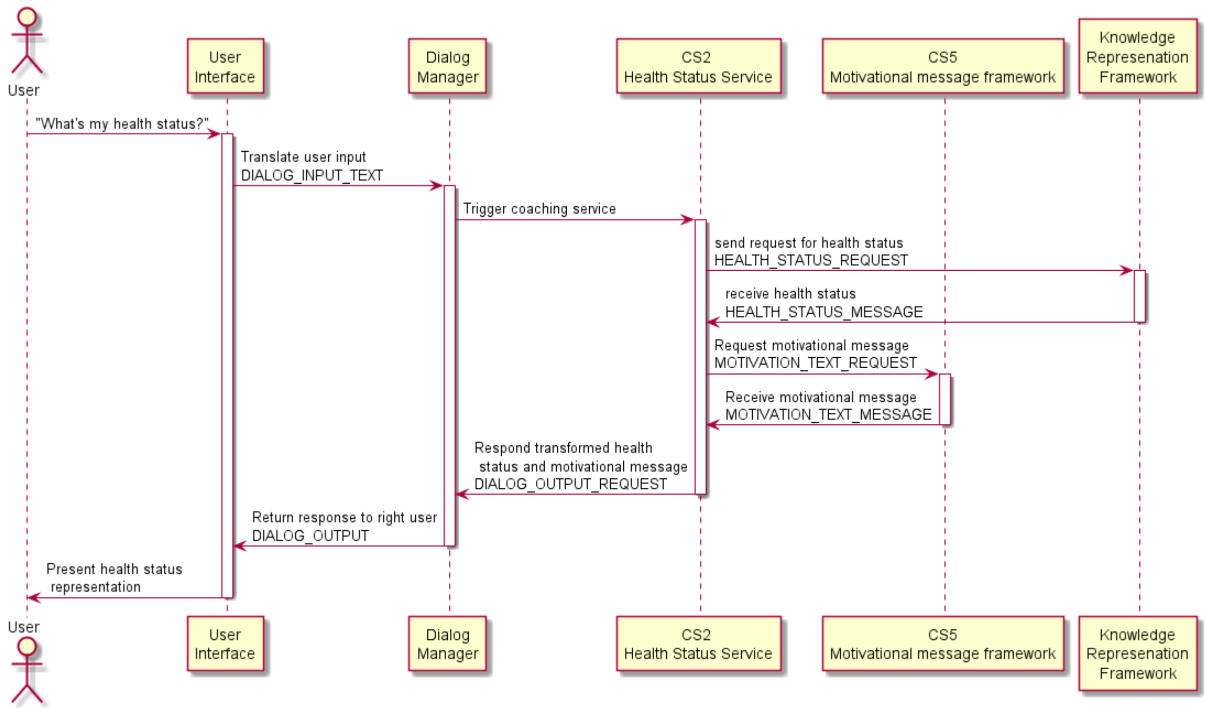

Figure 57: Data flows for test A-2 SD – CS2 – R5-5

Test execution:

- **Trigger**: a technician at AIT triggers the test by asking for the current health status via speech input on the tablet.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** It is tested if the health status message sent back form the KRF is shown on the UI.

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
Input is the verbal command "What's my health status" which is then recognized and transformed into the MQTT message HEALTH_STATUS_REQUEST and sent to the KRF	The output is the health status on the tablet textual form presenting the performance of the activities performed recently.	Clinicians are satisfied; the test reflects their expectations anyway content and presentation of health status need of better understanding and detail.

Test summary:

We validated the technical components in an integrated environment at the AIT tech lab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 57 were supervised by technical people by help of the log files.

7.1.3 Test report Activity A-3 SD: E-learning

Services and requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
E-Learning	CS-4	R5-2
Detection of activities of daily living	DS-7	R2-8, R2-9
Agenda	SS-2	R3-1, R3-7
Standby	SS-3	R3-11

Test case

<table>
<tr><td colspan="2" align="center">Activity: E-LEARNING
(TEST 1: RISK FACTOR MODIFICATION)</td></tr>
<tr><td colspan="2">Initial setting (from D1.3): As part of the First narrative/Use Case #2, Maria profile’s at discharge from the hospital composed by

ONTOLOGY (from D1.3/D4.2):
– “Patient profile”: pathology (e.g. stroke), clinical data depicting the clinical syndrome, clinical classification of patient at discharge (e.g. “Faller”)
– “Clinical State”: Mini-BESTest
– “Evidence Indicators”: Educational and e-learning time spent.
– “Activity”: Supervision of risk behaviour
– “Time Event”: free (no predefined schedule)

REASONER (from D1.3):
– Rules for fall risk (Rules D1.3 pg. 52, [Use Case: UC2 Linked Measure: Patient classify at fall risk])
– Rules for fall risk (Rules D1.3 pg. 53, [Use Case: UC2 Linked Measure: home environmental monitoring (rooms permanence and time spent in these rooms])

TECHNOLOGY from (D7.2):
– Tablet
– Object detector</td></tr>
<tr><td rowspan="2">Services: DS-7 Detection of activities of daily living</td><td>Requirement: R2-9 Deviation behaviour detection</td></tr>
<tr><td>Context:
The VC detected during the past days that the user was not walking indoor with the prescribed aid. Therefore, it provides the user with an e-learning lesson concerning the risk of falling at home and suggests it to the user.

Test:
– Data simulating potential falling risk during the past weekly history are inserted into the system
– The technician verifies that the reasoner acknowledges the potential falling risks by checking for hazard events in the patient risk management chart
– The technician verifies that IF falling risk during past days, THEN the reasoner checks for suitable e-learning contents in the multimedia library
– The technician verifies that the reasoner informs the user that a new e-learning lesson is available in the tablet
– The technician checks the logfiles to verify that the system includes e-learning activity in the agenda service</td></tr>
</table>

Test documentation

Integration:
This test subscribes to the 'WalkingWithOutAid' event and assesses the risk of falling based on the history of such events during the previous week.

When this risky situation is detected, the DS7 notifies the E-Learning service that specific materials should be reinforced for the patient.

Test setup - precondition:
The patient has a history of walking without the aid during the previous week: at least 1 event per day has been registered in at least 6 days.
The event generated in day 7 will trigger the risk of fall assessment and the corresponding service will be notified.
The message flows are as depicted in the figure below.

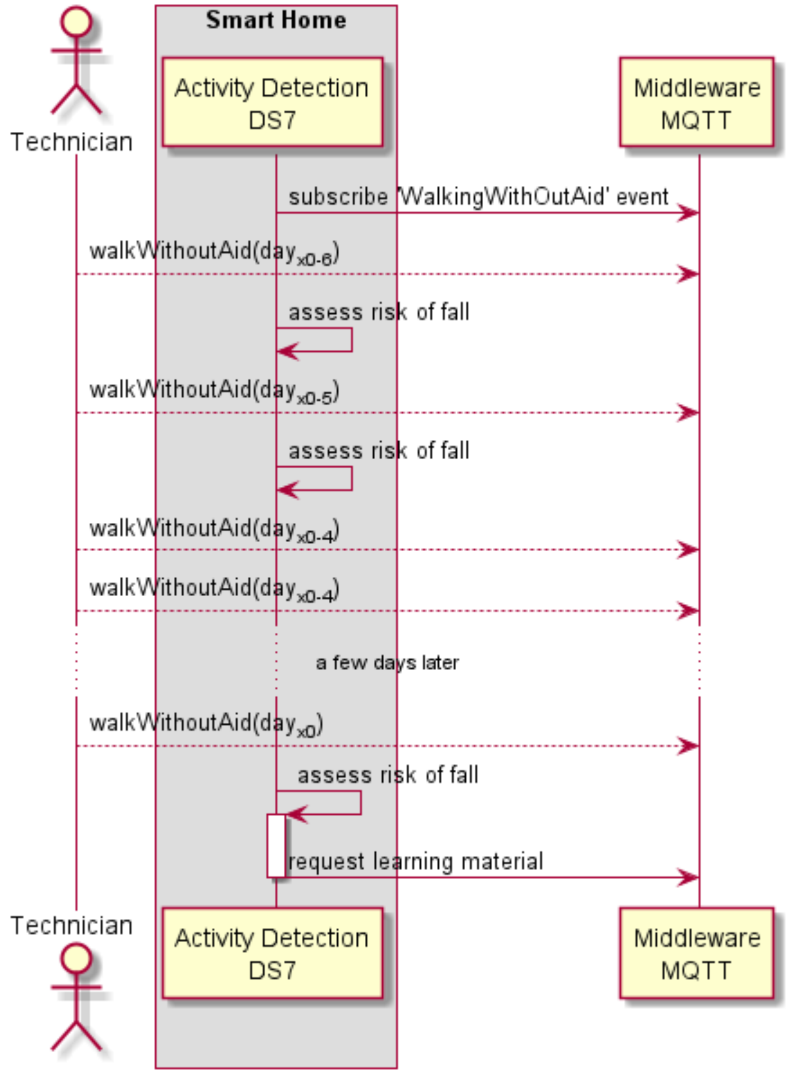

Figure 58: Data flows for test A-3 SD – CS7 – R2-9

Test execution:

- **Trigger**: the DS7 execution is triggered manually feeding events during several days to trigger the risk of fall assessment.
- **Integration test**: message flow between components is verified.

Test validation:
The DS7 is generating a message to the message/service/message with contents:

```
{
  "topic": "vcare/${patientId}/message/service/message",
  "properties": {
      "INTERACTION_ID": "9234309645758423",
      "TIMESTAMP": "116649992737",
      "USER_ID": "${patientId}",
      "CONTENT": {
      },
      "ELEARNING_CONTENT_ID": "RISK_OF_FALLING"
  }
}
```


Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
The test evaluates the risk of falling conditioned to the event that the patient, requiring a walking aid, is not using it	The DS7 detects that this behavior is repeating over a period of 1 week and sends a request to vCare to trigger educational contents to persuade the patient about the importance of not walking without the aid.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated that the home activity detection service can is correctly triggering the assessment of risk of falling whenever the 'WalkingWithoutAid' event is triggered. When this event happens too often, the service correctly requests educational materials.

Services: **CS-4 E-Learning**	*Requirement*: **R5-2 E-learning**
	Context:

	The VC starts the suitable e-learning educational and informative contents in form of a video for home fall risk prevention and plays it on the tablet. **Test:** – The technician verifies that IF falling risks during the past days AND IF a suitable e-learning lesson is available, THEN the Virtual Coach asks to the user if he wants to participate in a virtual lesson on "falling risk at home" – The user agrees – The technician checks the database entries to verify the storage of the positive answer – The technician checks the logfiles to verify that IF positive answer, THEN the Virtual Coach unlocks the lesson in the multimedia library and launches the lesson

Test documentation:

Integration:

The test involves the avatar base UI on the tablet, the dialog manager, the KRF and the e-learning service (CS4). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving the e-learning content by the user on the UI running on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. To model the initial situation, appropriate simulated information on the patient fall risk and available e-learning sessions is stored in the knowledge layer. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 59 below.

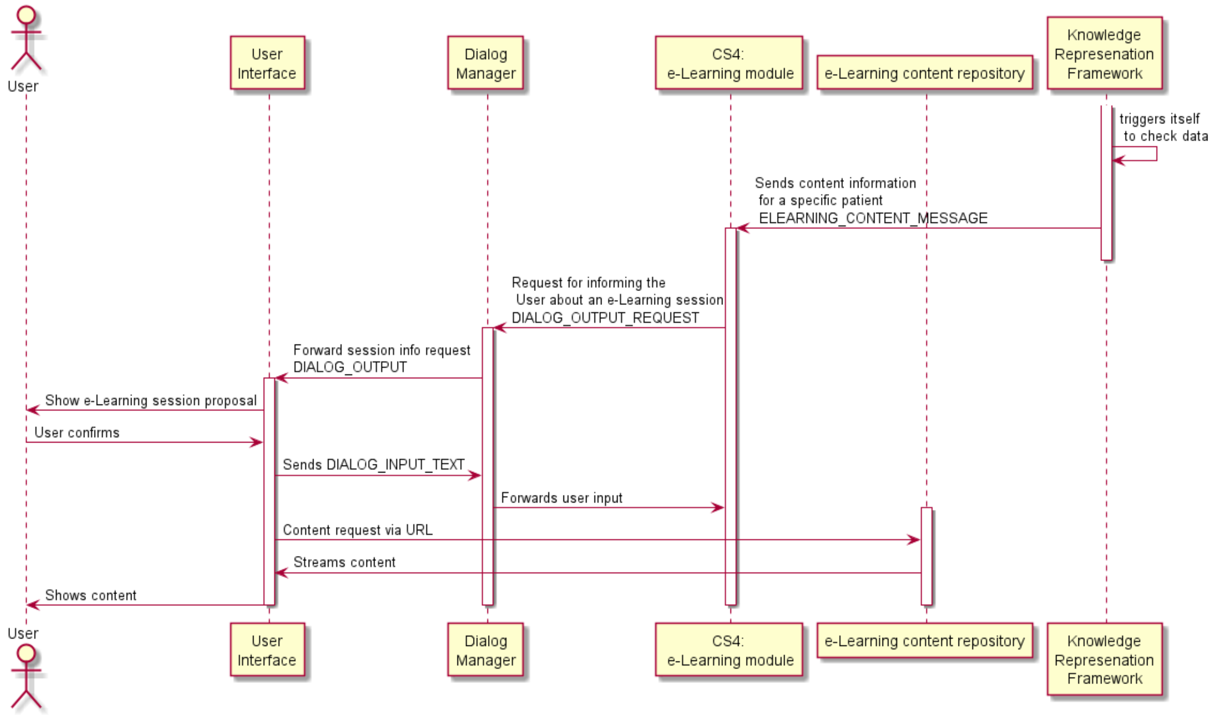

Figure 59: Data flows for test A-3 SD – CS4 – R5-2

Test execution:

- **Trigger**: a technician at FZI triggers the test by setting the appropriate thresholds needed to invoke the e-learning message by the reasoner.
  - **Integration test:** the message flow through all components was tested.
  - **Interaction test:** It is tested if the e-learning session is established on the UI.

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
The KRF is triggered manually to send the ELEARNING_CONTENT_MESSAGE message to the e-learning service (CS4). After confirmation of the user, the video as defined in the message is accessed and streamed.	Presentation of e-learning content in form of a video on the UI.	Clinicians are satisfied; the test reflects their expectations.

Test summary:
We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 59 were supervised by technical people by help of the log files.

<table>
<tr><td colspan="2">Activity: E-LEARNING
(TEST 2: PHYSICAL THERAPY)</td></tr>
<tr><td colspan="2">Initial setting (from D1.3): As part of the First narrative/Use Case #2, Maria profile's at discharge from the hospital composed by

ONTOLOGY (from D1.3/D4.2):

– "Patient profile": pathology (e.g. stroke), clinical data depicting the clinical syndrome, rehabilitation goals for the body district to be recovered (e.g. upper limbs)
– "Clinical State": ARAT
– "Evidence Indicators": adherence to motor rehabilitation programme, educational and e-learning time spent, VAS
– "Activity": session of e-learning lessons as an alternative to physical rehabilitation treatment
– "Time Event": free (no predefined schedule)

REASONER (from D1.3):

– Rules for pain risk (Rules D1.3 pg. 52, [Use Case: UC2 Linked Measure: VAS (pain)]

TECHNOLOGY from (D7.2):

– Sensor based training system (REHABILITY)
– Tablet</td></tr>
<tr><td rowspan="2">Services: SS2 Agenda</td><td>Requirement: R3-1 Coach main interactive application, the avatar</td></tr>
<tr><td>Context:
The avatar, through direct user interaction, asks the patient if he wants to begin his scheduled motor rehabilitation session through serious games now. The user rejects, his arm is painful. Therefore, the avatar proposes, as an alternative tool foreseen in the clinical pathway, a series of e-learning lessons about mobility of the upper limbs.
The user accepts.

Test:

– Data simulating the alternative activities that can be performed by the user are inserted into the system: the user can assist to e-learning lessons related to motor rehabilitation in alternative to motor serious games
– The user does not show in front of the Kinect for 5 minutes after the reminder of the scheduled session
– The technician verifies that the time recorded in the database corresponds to 5 minutes.</td></tr>
</table>

	– The technician verifies that at the 5th minute the VC activates a sound alarm asking the user if he want to start the motor games session – The user disagrees – The technician verifies that IF negative answer, THEN the VC proposes an alternative activity inside the pathway solution available: e-learning lesson – The patient agrees

Test documentation:

Integration:

The test involves the avatar base UI on the tablet, the dialog manager, the KRF, the reminder service (CS6) and the e-learning service (CS4). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving the game session results by the end-user UI on the tablet.

Test setup - precondition:

This test consists of two setup parts: the first part covers Sub-test 1 and the second part covers the other sub-tests.

Test setup part 1 pathway modelling:

In order to model alternative activities in the individual care plan, scheduled activities are extended in the knowledge layer with information about conditions and related actions. In addition to chronological relations between activities, alternative activities can also be modelled. Several activities can be combined in one group.

```
"groupingBehavior": "logical-group",

"selectionBehavior": "exactly-one",
```

Followed by a set of activities of varying size. In this test case e-learning lessons related to motor rehabilitation and motor serious games are model in the knowledge layer.

Test setup part 2 message flow:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 60.

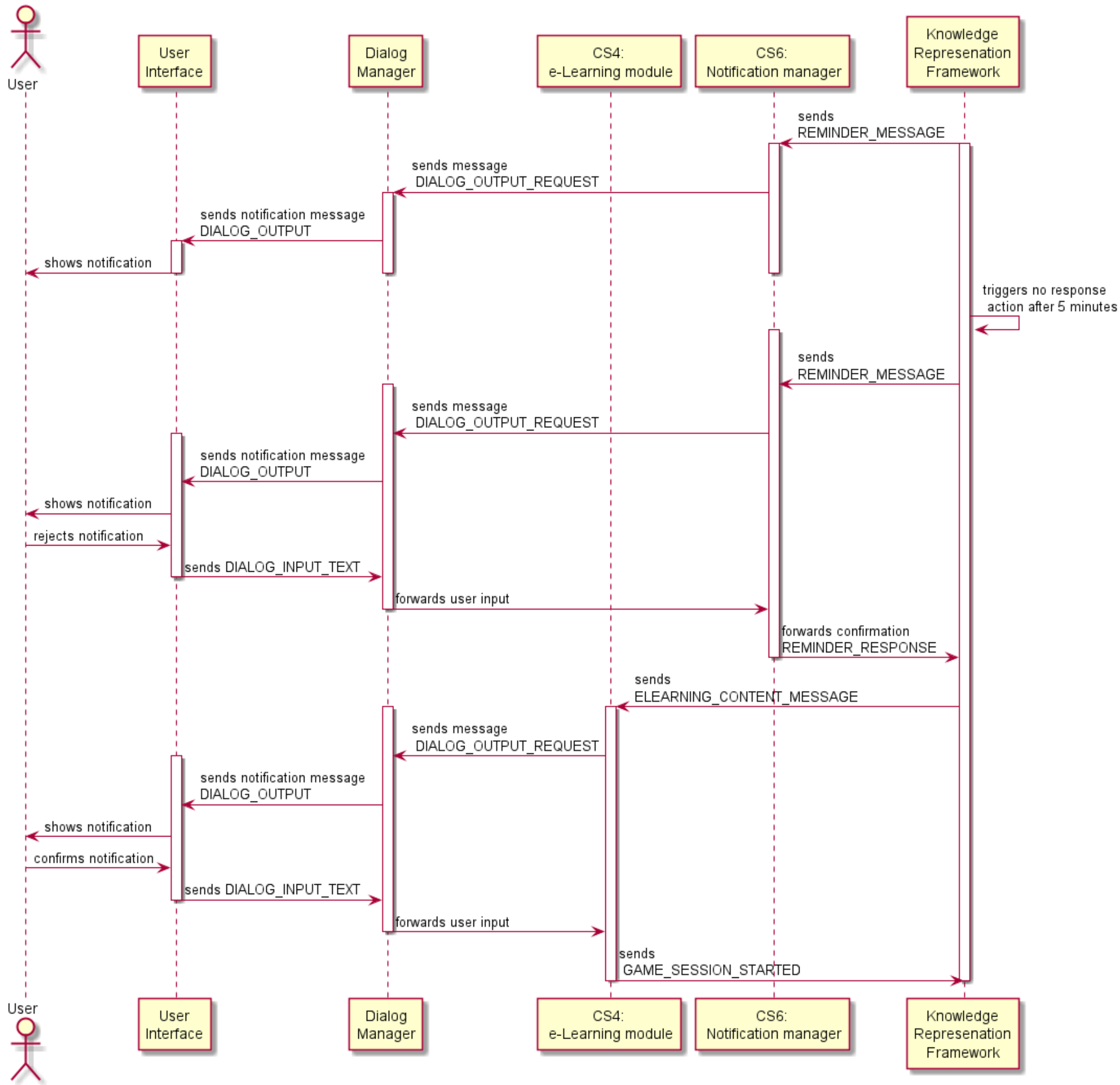

Figure 60: Data flows for test A-3 SD – SS2[13]

Test execution:

- **Trigger**: a technician at FZI triggers a reminder for a physical training session sending the related MQTT message to the CS6. After 5 minutes without response another reminder is sent.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** It is tested if the e-learning session has been started on the UI

[13] NOTE: SS2 is not required for this test. Instead, CS4 and CS5 cover the requirements of this test

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
The input is a REMINDER message generated manually by the KRF. After a dialog with the user an ELEARING_CONTENT_MESSAGE is sent	The output is a series of notifications with response options for the user. At the end, a confirmation message is sent to the KRF.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 60 were supervised by technical people by help of the log files.

Services: **CS-4 E-Learning**	*Requirement*: **R5-2 E-learning**
	Context: The VC starts the suitable content on physical activity for the upper limbs and plays it on a tablet. **Test:** - The technician checks the logfile to verify that IF positive answer, THEN the Virtual Coach opens e-learning service and launches the lesson

Test documentation:

Integration:

The test involves the avatar base UI on the tablet, the dialog manager, the KRF and the e-learning service (CS4). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving the e-learning content by the user on the UI running on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 61 below.

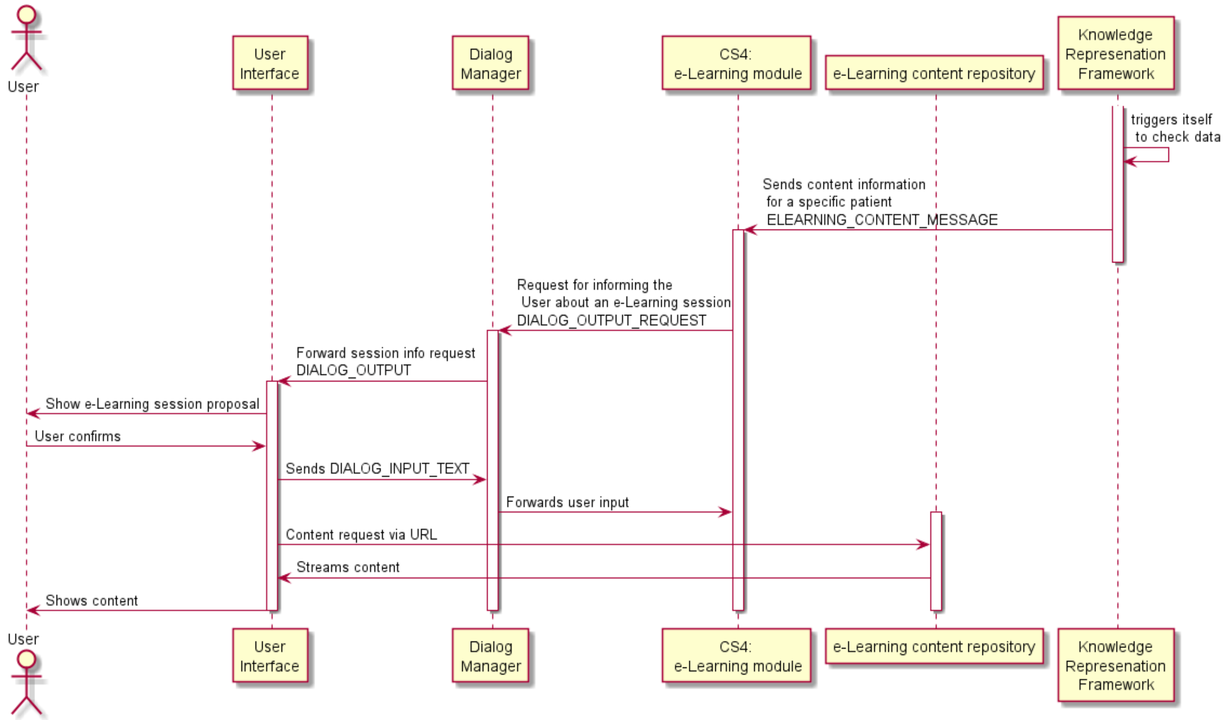

Figure 61: Data flows for test A-3 SD – CS4

Test execution:

- **Trigger**: a technician at FZI triggers the test manually invoking the ELEARNING_CONTENT_REQUEST sent to the CS4.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** It is tested if the e-learning session is established on the UI.

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
The KRF is triggered manually to send an ELEARNING_CONTENT_MESSAGE to the e-learning service (CS4). After confirmation of the user, the video as defined in the message is accessed and streamed.	Presentation of e-learning content in form of a video on the UI.	Clinicians are satisfied; the test reflects their expectations.

Test summary:
We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 61 were supervised by technical people by help of the log files.

7.1.4 Test report Activity A-5 SD: Fun supporting activities

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Health status	CS-2	R5-5
Rehabilitation coach	CS-5	R3-6, R4,6
Intelligent notifications scheduler	CS-6	R2-7, R2-8, R3-1, R3-6, R5-3, R5-4
User Feeling	CS-8	R5-6
Standby	SS-3	R3-11

Test case

<table>
<tr><th colspan="2">Activity: FUN SUPPORTING ACTIVITIES</th></tr>
<tr><td colspan="2">Initial setting (from D1.3): As part of the Second narrative/Use Case #3, Mr. Giuseppe profile's at discharge from the hospital composed by

ONTOLOGY (from D1.3/D4.2):

– "Patient profile": pathology (e.g. stroke), clinical data depicting the clinical syndrome
– "Evidence Indicators": user liking, activity duration
– "Activity": Cognitive leisure activity
– "Time Event": free (no predefined schedule)
– "Assessment Documents": the VC system sends a concise report (document) to the neuropsychologist

TECHNOLOGY from (D7.2):

– Tablet</td></tr>
<tr><td rowspan="2">Services: CS6 Intelligent notifications/scheduler</td><td>Requirement: R3-7 Agenda interface</td></tr>
<tr><td>Context:
The user asks the VC to know what upcoming activity are scheduled. The VC understands and processes the user's request.</td></tr>
</table>

	Test: *Already tested in SD A-1 Home-based Motor Activities, Services:* SS-2 Agenda, *Requirement:* R3-7Agenda interface

Services: **CS5 Rehabilitation coach**	*Requirement:* **R4-6 Personalized and context-aware interaction and feedback**
	Context: The VC finds no upcoming activities scheduled in the agenda. Therefore, the reasoner checks for an additional activity among those available in the clinical pathway. **Test:** - The technician verifies that IF no other activities are scheduled at the current time, THEN the reasoner detects in the clinical pathway a potential *fun supporting activity*

Test documentation:

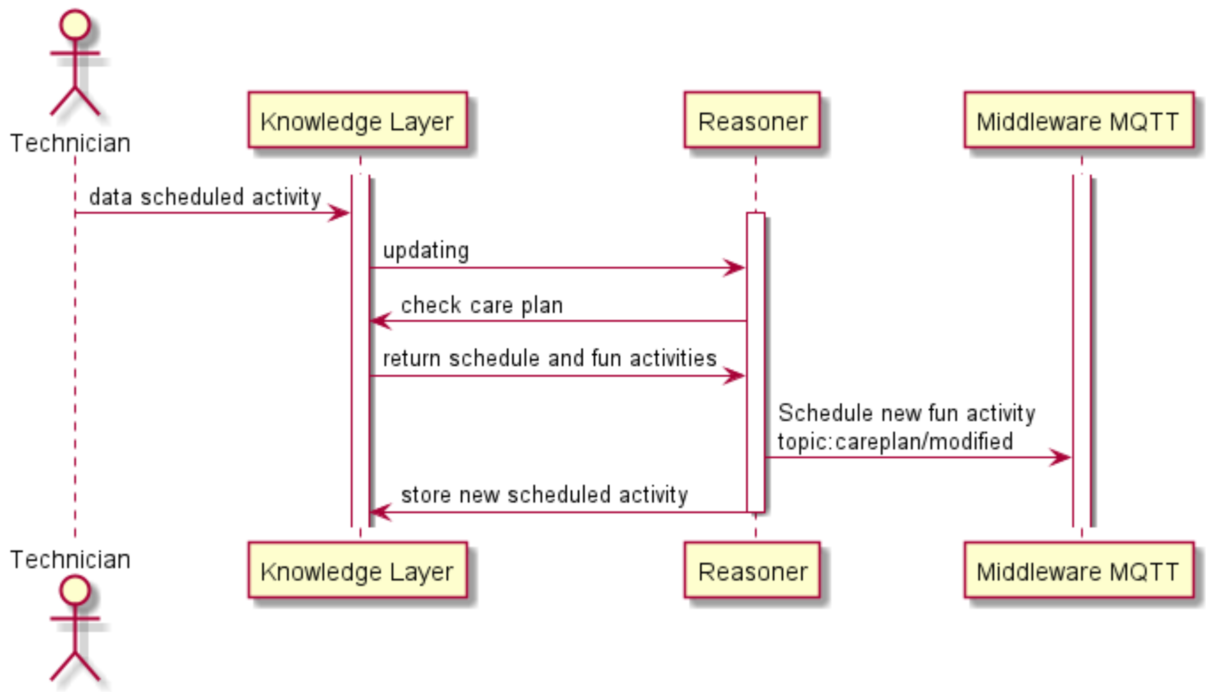

Figure 62: Data flows for test A-5 SD – CS26 – R4-6

Integration:

Processing the individual careplan of a patient is executed within the knowledge layer. For this purpose, we can extract this information from our RDF-files in the triple store in a predefined way (see **D4.3** and finalised in **D4.4**).

After processing the information stored in the reasoner according to the definition in the use case the framework then proposes a new scheduled activity to be added to the patients care plan for this day. The proposed activity is limited to be one of predefined “fun supporting” activities. During the TechLab and the exchange with our medical partners we defined a list of fun supporting activities from a medical point of view that can be included in the knowledge layer and therefore can be crawled when searching for a potential fun activity.

The result of this process is the modification of an individual care plan by adding a new scheduled fun activity (as defined in **D6.4**) to the care plan. Since this technical component is validated in an integrated environment the information is provided to the central middle ware server via the MQTT broker to the topic "vcare/<<patientId>>/careplan/modified".

Test setup - precondition:

- Simulated information about scheduled activities for an individual sampled care plan instance are inserted to the knowledge layers RDF-store
- Integrated tests on proposing activity

Test execution:

- **Reasoner:** automatically checks if no activities are scheduled during the morning or during the evening (see further specifications during TechLab in section **Comment medical partners**)
- Proposes fun activity (e.g. serious game) as a new scheduled activity to the broker

Test validation:

- the reasoner queries the knowledge layer of a specific patient for scheduled activities where the “timing” attribute hold the daytime the activity should be performed.
- the reasoner generates a new scheduled activity as defined in the ontology (**D4.3**) and provides this information to the topic of the patient’s individual care plan
- in this use case the new scheduled activity timing is selected at random within defined boundaries of morning [8:00-11:00] and afternoon [13:00-18:00]. In the long run this parameterisation is part of the individualization of a care plan. The smart agent is trained on the individual patients’ reactions (personal state, clinical state) on multiple scheduled activities and will get better at optimizing the parameters of an activity as well as the scheduled time by each iteration.

Test Cases	Times of scheduled activities	New scheduled activity
TC-01	[8:00,10:00,14:00,17:00]	None
TC-02	[14:00,17:00]	[10]
TC-03	[8:00,10:00]	[15]

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)

To test this use case, we simulate a patient and store information about a simulated agenda in our knowledge graph. We also insert information about the patients habit of walking outside, that would be extracted as a pattern in the long run.	VC proposes the coaching for an active lifestyle activity: “walking outdoor at 6km/h for 30 minutes”	The VC proposes a fun supporting activity if the patient has no other scheduled activities during the entire morning or the entire afternoon.

Test summary:

The test defined here forms an important basis for the long-term personalization of a clinical pathway.

First and foremost is the processing of existing information about an individual clinical pathway in Knowledge Layer. While we were able to show in this test that the planned daily routine from the use case is processed accordingly, the long-term personalization of a care plan can be derived from this.

<table>
<tr><td rowspan="2">Services: CS6 Intelligent notifications/scheduler</td><td>Requirement: R3-1 Coach main interactive application, the avatar</td></tr>
<tr><td>Context:
The VC suggests to the user a fun supporting activity among those available in the clinical pathway: crossword quiz. The user accepts.

Test:
– The Virtual Coach suggests to the patient the selected fun supporting activity: crossword quiz using a third-party app not integrated in vCare
– The patient agrees.
– The technician verifies the reception of the positive answer by checking the database entries
– The technician verifies that IF positive answer, THEN the reasoner updates agenda manager application including current activity</td></tr>
</table>

<u>Test documentation:</u>

Integration:

The test involves the avatar base UI on the tablet, the notification manager service (CS6), die dialog manager and the reasoner (the KRF). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of the reminder for fun activity on end-user UI and the receiving of the response by the reasoner which stores it in the database.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 63.

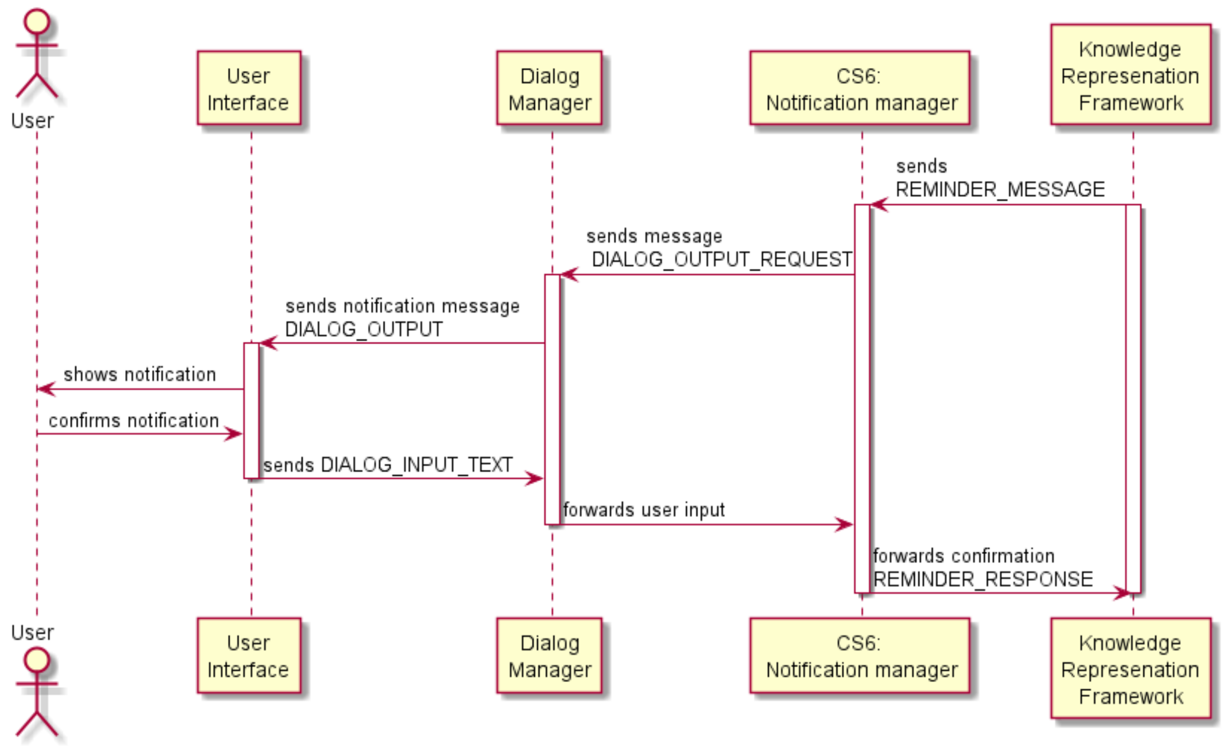

Figure 63: Data flows for test A-5 SD – CS6

Test execution:

- **Trigger:** the reminder is triggered by the KRF manually for the test.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** The reminder has been shown on the tablet via speech output and a textual reminder message and the user can confirm the proposal

Test validation:

- The log of the end-user UI is checked if the response could be received.
- The KRF is checked if the response has been received

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)

The input is a manually generated REMINDER_MESSAGE sent by the KRF to show a notification with response option on the UI	The output is the dedicated reminder response sent back to the KRF	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 63 were supervised by technical people by help of the log files.

<table>
<tr><td rowspan="2">Services: CS5 Rehabilitation coach</td><td>Requirement: R3-6 Information interface</td></tr>
<tr><td>Context:
VC informs the user to start the crosswords quiz.

Test:
- The user starts playing the crosswords quiz using a third-party app which is not integrated into the vCare system
- The technician checks the logfiles to verify that, at the end of the session the UI view has returned to the Virtual Coach</td></tr>
</table>

Test documentation:

Integration:

The test involves the avatar base UI on the tablet and is a continuation of the test A-5 SD – CS6. The result of the test is that the vCare App is back in foreground after the user has finished using a third-party app.

Test setup - precondition:

The performance and end-state of the test A-5 SD – CS6. There is no message flow within this test. The interaction flow is depicted in Figure 64.

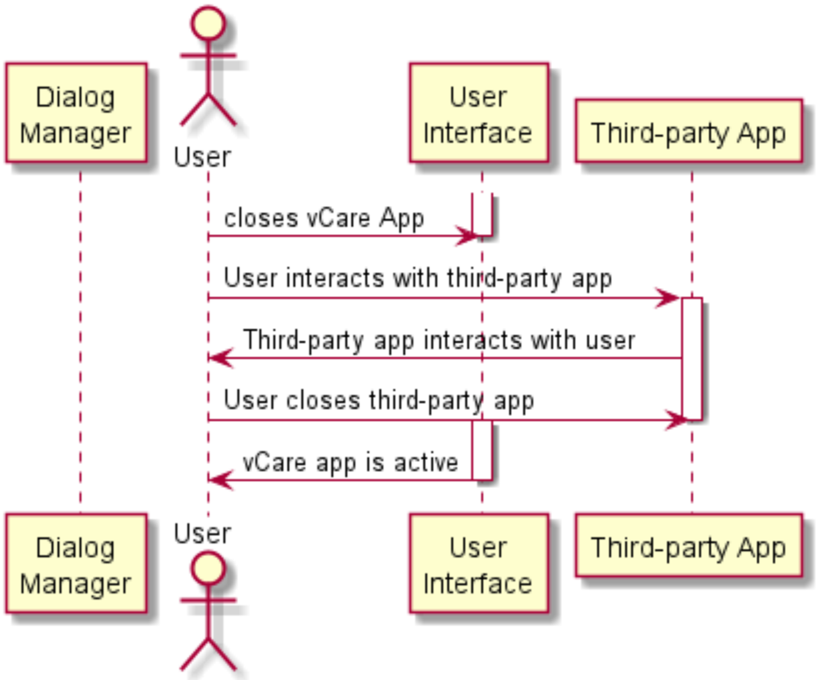

Figure 64: Interaction flow for test case A-5 SD - CS5

Test execution:

- **Trigger**: the tester starts a third-party app.
  - **Integration test:** there is not integration test for this test.
  - **Interaction test:** the vCare app is in foreground after closing the third-party app.

Test validation:

- The vCare UI is active again after closing the third-party app.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
This this doesn't involve any message flow. The input is the tester opening another app.	Output is the vCare app to be shown again after the third-party app has been closed.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab. The vCare app was back in foreground at the end what was validated visually.

7.1.5 Test case Activity A-9 SD: Monitoring pain and sleep

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Medical questionnaires	CS-7	R5-7
Agenda	SS-2	R3-1, R3-7
Standby	SS-3	R3-11

Test case

Activity: MONITORING PAIN AND SLEEP	
Initial setting (from D1.3): As part of the First narrative/Use Case #1, Maria profile's at discharge from the hospital composed by **ONTOLOGY** (from D1.3/D4.2): – "**Patient profile**": pathology (e.g. stroke), clinical data depicting the clinical syndrome, rehabilitation goals for the body district to be recovered (e.g. upper limbs) – "**Clinical State**": ARAT – "**Evidence Indicators**": VAS scale score – **"Activity":** Supervision of risk behaviour – **"Time Event":** free (no predefined schedule) – **"Assessment Documents":** the VC system sends a concise report (document) to the caregiver **REASONER** (from D1.3): – Rules for exceptional procedure (Rules D1.3 pg. 51, [*Use Case: UC1. Linked Measure: Pain; VAS Scale*]) **TECHNOLOGY** from (D7.2): – Tablet – REHABILITY	
Services: **CS-7 Medical questionnaires**	*Requirement*: **R5-7 Questionnaires**
	Context: At the end of a rehabilitation physical activity, the VC displays the user a visuo-analogical scale (VAS) on the pain perception (joint, headache, dizziness, sickness). The user is able to self-administer the assessment scale. The VC asks for confirmation and saves the result obtained.

	Test: – The user starts REHABILITY – The technician checks the logfiles to verify that every time the rehabilitation session ends, the VAS scale is displayed on the UI on the tablet – The user grades his level of pain – The technician verifies that the reasoner records the self-evaluation and report it in the patient risk management chart by checking the information stored into the database

<u>Test documentation:</u>

Integration:

The test involves the avatar base UI on the tablet, the dialog manager, the KRF and the medical questionnaire service (CS7) and the physical training service (CS1). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of the questionnaire result by the KRF.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 65 below.

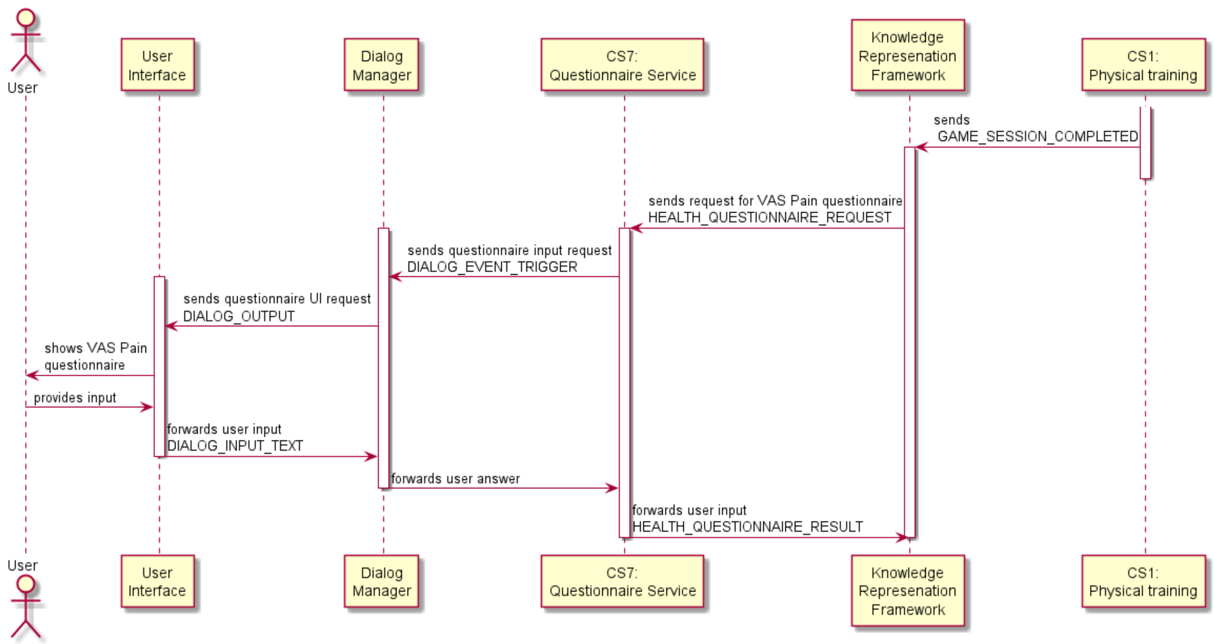

Figure 65: Data flows for test A-9 SD – CS7

Test execution:

- **Trigger**: the KRF simulates the end of a physical game and triggers the VAS pain questionnaire.

- **Integration test:** the message flow through all components was tested.
- **Interaction test:** The reminder has been shown on the tablet via speech output and a textual reminder message and the response is received by the reasoner (the KRF)

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
The input is a GAME_SESSION_COMPLETED message which is generated manually to trigger the test case. Based on that the KRF triggers a HEALTH_QUESTIONNAIRE_REQEUST msg.	The output is the result of the questionnaire sent back to the KRF.	Clinicians are satisfied; the test reflects their expectations.

Test summary:
We validated the technical components in an integrated environment at the AIT tech lab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 65 were supervised by technical people by help of the log files.

7.2 Activity test Report–Parkinson's disease

A Test case for each one of the following Activities related to Parkinson's Disease (PD) listed in D1.4 – Annex 6.6 has been defined and will be described henceforth:

Table 24 - List of Activities related to Parkinson's Disease (PD) as listed in D1.4 - Annex 6.6

Activity (A)	A #	Other Paths	Medical Use Case UC #	Needs	Medical Priority (1=high, 4=low)
Home-based motor activities	A-1	SD	UC1, UC5, UC6	Physical therapy	1
Coaching for an active lifestyle	A-2	SD	UC1, UC4, UC5, UC6	Physical therapy	3
E-learning	A-3	SD, HF, IHD	UC1, UC2, UC5, UC6, UC7, UC9, UC10, UC11	Physical therapy, Cognitive training, Risk Factor Modification.	2

Home-based cognitive games	A-4	SD	UC3, UC4, UC6	Cognitive training	2
Fun supporting activities	A-5	SD	UC3	Cognitive training	3
Monitoring mood	A-8	SD, IHD	UC3, UC4, UC5, UC13	Emotional and Social rehabilitation	2
Monitoring pain and sleep	A-9	SD	UC1	Pain and sleep	4
Vocal exercises	A-10			Speech and swallowing therapy	4
Falls prevention	A-11		UC6	Risk Factor Modification	1
Medication intake support	A-15	HF, IHD	UC5, UC7, UC12	Pharmacological intervention	1

7.2.1 Test case Activity A-1 PD: Home-based motor activities

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Physical Training	CS-1	R5-8
Health status	CS-2	R5-5
Rehabilitation coach	CS-5	R3-6, R4,6
Intelligent notifications scheduler	CS-6	R2-7, R2-8, R3-1, R3-6, R5-3, R5-4
User Feeling	CS-8	R5-6
Body position detection	DS-2	R2-3
Agenda	SS-2	R3-1, R3-7

Test case

<table>
<tr><th colspan="2">Activity: HOME-BASED MOTOR ACTIVITIES</th></tr>
<tr><td colspan="2">Initial setting (from D1.3): As part of the First narrative/Use Case #5 and #6, Mr. Alvarez profile's at discharge from the hospital composed by:

ONTOLOGY (from D1.3/D4.2):
– "Patient profile": pathology (e.g. PD), clinical data depicting the clinical syndrome, rehabilitation goals for the body district to be recovered (e.g. upper limbs)
– "Clinical State": UPDRS
– "Evidence Indicators": UPDRS and serious game scores
– "Activity": physical rehabilitation treatment composed by 5 games
– "Time Event": contain the sequences of rehabilitation treatments (e.g. 30 minutes/day, 3 days/week)
– "Assessment Documents": report (document) with the scores of 2 weeks of activity in the clinic (Popping Flowers game and Coloured Cans)

REASONER (from D1.3):
– Rules to activate exceptional procedure (Rules D1.3 pg. 56, [Use Case: UC5 and UC6. Linked Measure: Improve gait and balance, axial posture and flexibility: Sense4care)
– Rules to provide a positive feedback after game (Rules D1.3 pg. 59, [Use Case: UC5 and UC6. Linked Measure: Game score (to manage game difficulty level)]
– Rules to manage game difficulty level (Rules D1.3 pg. 59, [Use Case: UC5 and UC6. Linked Measure: Game score (to manage game difficulty level)]
– Rules to manage fatigue (Rules D1.3 pg. 60, [Use Case: UC5 and UC6. Linked Measure: Fatigue: VAS-F (Visual Analogue Scale for Fatigue)]

TECHNOLOGY from (D7.4):
– Sensor based training system (REHABILITY)
– Activity tracker</td></tr>
<tr><td rowspan="4">Services: SS2 Agenda</td><td>Requirement: R3-7 Agenda interface</td></tr>
<tr><td>Context:
The user asks the VC to consult the agenda to know the upcoming scheduled activities.

Test:
Already tested in SD A-1 Home-based Motor Activities, Services: SS-2 Agenda, Requirement: R3-7 Agenda interface</td></tr>
<tr><td>Requirement: R3-1 Coach main interactive application, the avatar</td></tr>
<tr><td>Context:
The user asks to know what upcoming activities are scheduled in his agenda for today through direct interaction with the avatar

Test:
Already tested in SD A-1 Home-based Motor Activities, Services: SS-2 Agenda, Requirement: R3-1Coach main interactive application, the avatar</td></tr>
<tr><td></td><td>Requirement: R3-6 Information interface</td></tr>
</table>

Services: **CS5 Rehabilitation coach**	**Context**. The avatar displays on screen and announce by voice what is the next scheduled activity on the agenda: the motor rehabilitation through the serious games of REHABILITY will start in an hour after taking the medication. **Test:** *Already tested in SD A-1 Home-based Motor Activities, Services:*CS-5Rehabilitation Coach*, Requirement:* R3-6Information interface
Services: **CS6 Intelligent notifications / scheduler**	*Requirement:* ***R2-7 Home inactivity detection***
	Context. The user switches on the TV and Set-Top box. Half an hour (30 minutes) has passed, and the user has not yet started the motor rehabilitation session with serious games. The vCoach recognizes that the user is inactive on the couch and generates through the VC a notification to the user to invite him to go in front of the TV to start his session. **Test:** *Already tested in SD A-1 Home-based Motor Activities, Services:* CS6 Intelligent notifications / scheduler*, Requirement: R2-7 Home inactivity detection*

Services: **CS2 Health status**	*Requirement:* ***R5-5 Health status***
	Context: Before starting the activity, the VC will take the vital signs (HR) in order to compare these outputs once the activity is finished. ***Test*** – Before starting with the activity, the VC stores the heart rate value from the activity tracker – The technician checks the database for the correct storage of these variables

Adjustment: Already testes in HF A-16 VITAL STATS CONTROL, Services: DS-5 Monitoring of vital parameters, Requirement: R7-1 Vital signs monitoring

Services: ***CS1 Physical Training***	*Requirement:* ***R5-8 Physical training***
	Context: The user is in front of the TV and starts REHABILITY. The VC asks the user to choose two games from the list of those prescribed by the therapist inside the clinical pathway. The user selects Popping Flowers and Coloured Cans. The user faces the serious game in standing position as planned by the clinical pathway. The VC at the end of the session displays the user game scores available in REHABILITY ***Test***

	Already tested in SD A-1 Home-based Motor Activities, Services: CS-1Physical Training*, Requirement:* R5-8Physical Training
Services: **CS5 Rehabilitation coach**	*Requirement:* ***R4-6 Personalized and context-aware interaction and feedback***
	Context. When the first exercise is finished, the VC gives a feedback about the user performance. **Test:** *Already tested in SD A-1 Home-based Motor Activities, Services:* CS-5 Rehabilitation Coach*, Requirement: R4-6 Personalized and context-aware interaction and feedback*
Services: **DS2 Body position detection**	*Requirement:* ***R2-3 Body position detection***
	Context: The user has finished the first of two games, sits down to rest for a while and when the second game starts, the user forgets to get back into standing position as instructed. As instructedREHABILITY sensor recognizes is/herwrong posture and sends the user a notification inviting him/her to stand up to continue the serious game in the optimal way. The user gets up and the game can resume. **Test**. *Already tested in SD A-1 Home-based Motor Activities, Services:* DS-2 Body position detection*, Requirement: R2-3 Body position detection*

Services: **CS8 User feeling**	*Requirement:* ***R5-6 User feeling***
	Context: Before starting any activity and when the activity is finished, the VC asks the user his general state and pain level showing a visuo-analogical scale on the tablet. The user indicates it and VC stores the information ***Test*** *Already tested in SD A-1 Home-based Motor Activities, Services:* CS8 User feeling*, Requirement: R5-6 User feeling*

7.2.2 Test case Activity A-2 PD: Coaching for an active lifestyle

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Location + activity monitoring	DS-1	R2-1, R2-6, R2-7
Weather	SS-1	R3-10

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Health status	CS-2	R5-5
Rehabilitation coach	CS-5	R3-6, R4,6
Intelligent notifications scheduler	CS-6	R2-7, R2-8, R3-1, R3-6, R5-3, R5-4
User Feeling	CS-8	R5-6
Detection of activities of daily living	DS-7	R2-8, R2-9
Standby	SS-3	R3-11

Test case

Activity: COACHING FOR AN ACTIVE LIFESTYLE

Initial setting (from D1.3): As part of the First narrative/Use Case #5 and #6, Mr. Alvarez profile's at discharge from the hospital composed by

ONTOLOGY (from D1.3/D4.2):

- "**Patient profile**": pathology (e.g. PD), clinical data depicting the clinical syndrome
- "**Evidence Indicators**": time of inactivity, number of steps, activity duration
- **"Activity":** outdoors physical activities
- **"Time Event":** free (no predefined schedule)
- **"Assessment Documents":** the VC system sends a concise report (document) to the physician

REASONER (from D1.3):

- monitoring of indoor motor activity (walking) (Rules D1.3 pg. 58, [*Use Case: UC5 and UC6 Linked Measure:number of steps 10 meters walking in a straight line*].
- monitoring of indoor motor inactivity (Rules D1.3 pg. 58, [*Use Case: UC5 and UC6 Linked Measure: Time of Inactivity [min], period, without interruptions, in which patient remains in the same position (no step performed)*].

TECHNOLOGY from (D7.2):

- Activity tracker
- Presence sensor
- STAT-ON

Services: **DS-1 Location of the patient in the house and home activity/inactivity monitoring**	*Requirement*: **R2-1 Home's room detection**
	Context: VC detects where is the user in the living room. **Test:** *Already tested in SD A-6Monitoring indoor, Services:* DS-1 Location of the patient in the house and home activity/inactivity monitoring, *Requirement:* R2-1 Home's room detection
	Requirement: **R2-7 Home inactivity detection**

	Context: An hour and a half have passed, and VC detects inactivity. **Test:** *Already tested in SD A-2 Coaching for an active lifestyle, Services:* DS-1 Location of the patient in the house and home activity/inactivity monitoring, *Requirement:* R2-7 Home inactivity detection
Services: **CS6 Intelligent notifications/scheduler**	*Requirement:* **R3-1 Coach main interactive application, the avatar**
	Context: The avatar through direct verbal interaction with the user asks the patient if he wants to know what upcoming activities are scheduled in his agenda for today or if he wants to perform different activities. **Test:** - The VC generates a notification to ask the user if he wants to check the agenda and start the activity scheduled or to perform a different activity - The user choses a different activity - The technician verifies the reception of the information by checking the database - The technician checks the logfiles to verify that IF the user wants to perform a different activity, THEN the VC proposes one of the *activities to maintain an active lifestyle*

<u>Test documentation:</u>

Integration:

The test involves the avatar base UI on the tablet, the notification manager service (CS6), die dialog manager and the reasoner (the KRF). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of the reminder for a training session by the end-user UI on the tablet and the return of an alternative choice sent to the KRF.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 66 below.

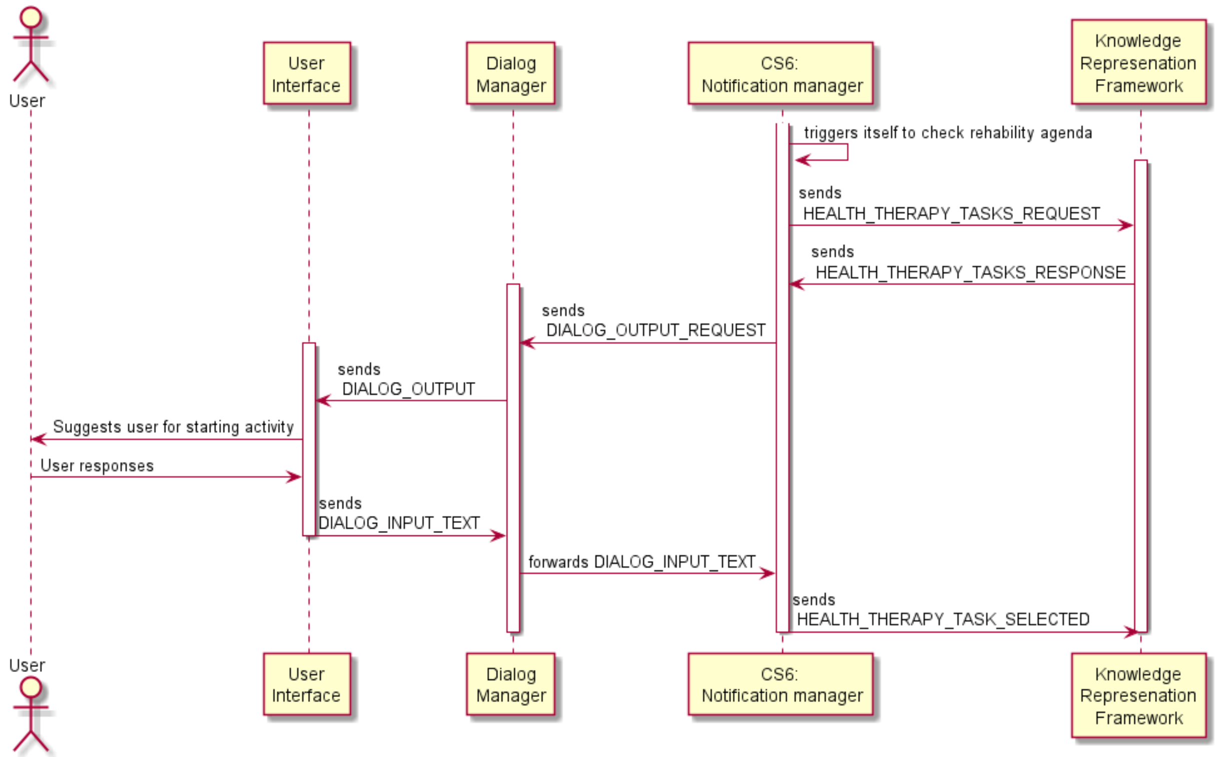

Figure 66: Data flows for test A-2 PD – CS6

Test execution:

- **Trigger:** the reminder is triggered by the KRF manually for the test.
  - **Integration test:** the message flow through all components was tested.
  - **Interaction test:** The suggestion for the activities is shown on the UI and the user can choose an alternative

Test validation:

- The log of the end-user UI is checked if the response could be received.
- The UI is checked visually

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
The CS6 is triggered manually to sent a HEALTH_THERAPY_TASKS_REQUEST to the KRF. Based on the result a dialog is triggered to ask the user to perform an activity of a list of options.	The output is the selected activity and sent via a HEALTH_THERAPY_TASK_SELECTED message.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 66 were supervised by technical people by help of the log files.

Services: **CS-8 User feeling**	*Requirement:* **R5-6 User feelings**
	Context: VC asks questions to the user regarding its subjective wellbeing, scoring with a 5-points Liker scale. **Test:** *Already tested in SD A-2 Coaching for an active lifestyle, Services:* CS-8 User feeling, *Requirement:* R5-6 User feelings
Services: **SS-1 Weather**	*Requirement:* **R3-10 Weather info**
	Context: The user asks the VC about current weather conditions. The VC provides verbally the current information about the weather. Depends on the weather, VC suggests to the user different possible activities to do after he finishes his activities scheduled. If the weather is good and sunny, suggest him going for a walk. If it is raining, VC sends a warning to be careful with possible falls and reminds him to take the umbrella. **Test:** *Already tested in SD A-2 Coaching for an active lifestyle, Services SS-1 Weather, Requirement: R3-10 Weather info*
Services: **CS5 Rehabilitation coach**	*Requirement*: **R4-6 Personalized and context-aware interaction and feedback**
	Context: The VC, considering the daily state of physical inactivity of the user protracted for a long time, considering the good weather, considering the user's compliance, and considering the reconstruction of his habits, proposes a physical activity among those available in the clinical pathway: a walk outside in the open air. **Test:** *Already tested in SD A-2 Coaching for an active lifestyle, Services:* CS5 Rehabilitation coach, *Requirement*: *R4-6 Personalized and context-aware interaction and feedback*
Services: **CS6 Intelligent notifications/scheduler**	*Requirement:* **R3-1 Coach main interactive application, the avatar**
	Context: The VC proposes to the user a walk outside. The user accepts. **Test:** *Already tested in SD A-2 Coaching for an active lifestyle, Services:* CS6 Intelligent notifications/scheduler, *Requirement:* R3-1 Coach main interactive application, the avatar

	Requirement: **R2-7 Home inactivity detection**
	Context: An hour and a half have passed, and the user is inactive on the couch. **Test:** *Already tested in SD A-2 Coaching for an active lifestyle, Services:* DS-1 Location of the patient in the house and home activity/inactivity monitoring, *Requirement:* R2-7 Home inactivity detection
Services: **DS7 Detection of activities of daily living**	*Requirement*: **R2-9 Deviation behaviour detection**
	Context: VC detects the daily routines of the users and acknowledges that he usually goes out for a walk at 12.00am VC detects the deviation expected behaviour since the patient at 12:00 am is inactive when he usually goes for a walk. **Test:** - Data simulating user's usual behaviour are inserted into the system: the user usually goes out for a walk at 12.00am - Pseudo data simulating the current time are inserted into the system: it's 12:00am - The user wears the Activity tracker and stays inactive for 5 minutes - The technician verifies the accuracy of data send via Bluetooth by the sensor and the reception of information about inactivity into the database entries - The technician verifies that VC sends the user a positive message to stand up and go out for a walk or for doing another outside activity.

Test documentation

Integration:

This test subscribes to the 'WalkingWithOutAid' event and assesses the risk of falling based on the history of such events during the previous week.

When this risky situation is detected, the DS7 notifies the E-Learning service that specific materials should be reinforced for the patient.

Test setup - precondition:

The patient has a history of walking without the aid during the previous week: at least 1 event per day has been registered in at least 6 days.

The event generated in day 7 will trigger the risk of fall assessment and the corresponding service will be notified.

The message flows are as depicted in the figure below.

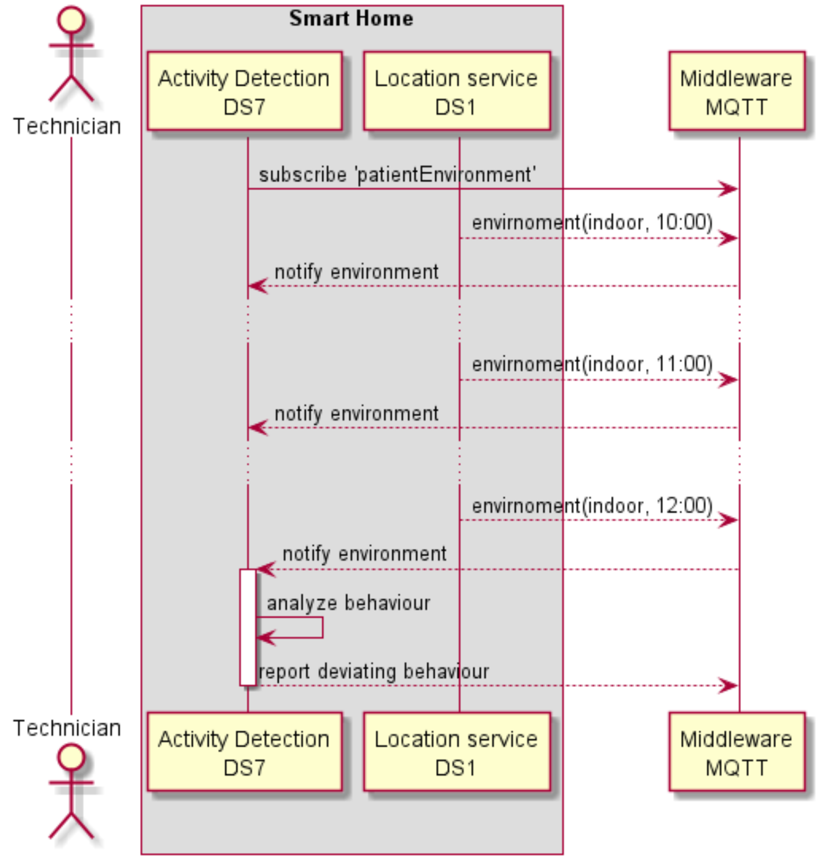

Figure 67: Data flows for test A-2 PD – CS7 – R2-9

Test execution:

- **Trigger:** the DS7 execution is triggered manually feeding events during several days to trigger the risk of fall assessment.
- **Integration test:** message flow between components is verified.

Test validation:

The DS7 is generating a message to the topic message/service/message with contents:


```
{

  "topic": "vcare/${patientId}/message/service/message",

  "properties": {

      "INTERACTION_ID": "9234309645758423",

      "TIMESTAMP": "116649992737",

      "USER_ID": "${patientId}",

      "CONTENT": {
```

```
        },
        "ELEARNING_CONTENT_ID": "<<Risk of falling>>"
    }
}
```


Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
The test evaluates the risk of falling conditioned to the event that the patient, requiring a walking aid, is not using it	The DS7 detects that this behavior is repeating over a period of 1 week and sends a request to vCare to trigger educational contents to persuade the patient about the importance of not walking without the aid.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated that the home activity detection service can is correctly triggering the assessment of risk of falling whenever the 'WalkingWithoutAid' event is triggered. When this event happens too often, the service correctly requests educational materials.

Services: **CS6 Intelligent notifications/scheduler**	*Requirement:* **R2-8 Home behaviour monitoring**
	Context: VC detects the daily routines of the users and it detects that the patient at 12:30 am is still at home when he usually goes for a walk at 12:00 am. **Test:** Already tested in PD A-2 Coaching for an active lifestyle, Services: DS-7 Detection of activities of daily living, Requirement: R2-9 Deviation behaviour detection

Services: **CS6 Intelligent notifications/scheduler**	Requirement: **R5-3 Notification and reminders**
	Context: The VC sends a verbal message that it is time to do some activity inside or outside. The user needs to accept it in order to stop the message. If it is not accepted, the VC will send a message every 10 minutes.

	Test: - The user does not accept the reminder - The technician verifies that the VC sends the same reminder after 10 minutes - The user accepts the reminder - The technician verifies that IF the user has accepted the reminder, THEN the VC does not send the reminder anymore

Test documentation:

Integration:

The test involves the avatar base UI on the tablet, the dialog manager, the KRF and the reminder service (CS6). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving the second reminder and its confirmation by the end-user UI on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 68.

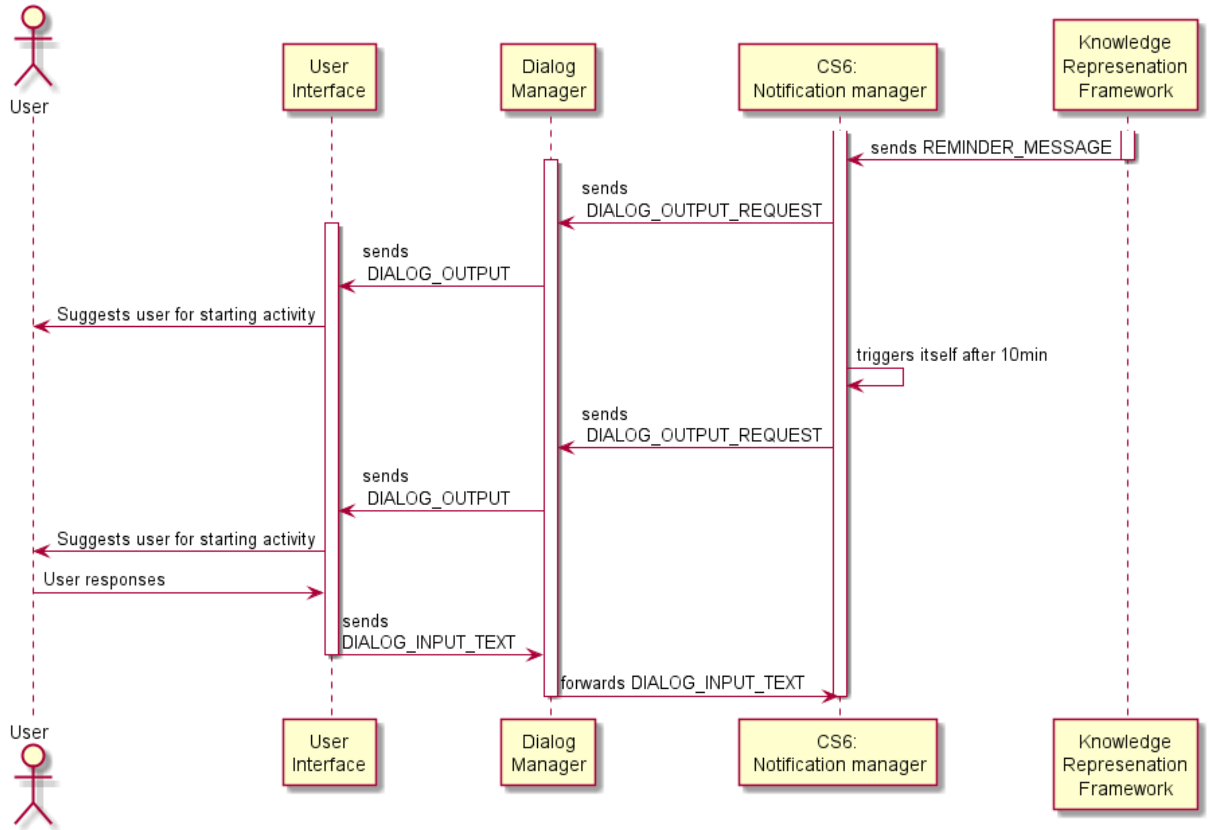

Figure 68: Data flows for test A-2 PD – CS6 – R5-3

Test execution:

- **Trigger**: a technician at FZI triggers a reminder for a training session sending the related MQTT message to the CS6. After 10 minutes without response another reminder is sent by the CS6.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** It is tested if the reminders are shown on the UI

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	**Output summary**	**Comment (Medical Partners)**
A REMINDER_MESSAGE is triggered manually within the KRF.	The output is the confirmation of the user as response to the reminder after the reminder has been sent a second time.	Clinicians are satisfied; the test reflects their expectations.

Test summary:
We validated the technical components in an integrated environment at the AIT tech lab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 68 were supervised by technical people by help of the log files. The responses on the UI were monitored visually.

Services: **CS6 Intelligent notifications/scheduler**	*Requirement:* **R3-1 Coach main interactive application, the avatar**
	Context: The Virtual Coach synthesizes an audio reminder, that recommends the user to wear suitable footwear and do not forget the walking aid. **Test:** - *Already tested in SD A-2 Coaching for an active lifestyle, Services:* CS-6 Intelligent notifications/scheduler, *Requirement:* R3-1 Coach main interactive application, the avatar

Services: **DS-1 Location of the patient in the house and home activity/inactivity monitoring**	*Requirement*: **R2-6 Activity monitoring**
	Context: The Sense4care device (STAT-ON) measures and monitors the motor symptoms and the ON-OFF states of the user. The VC keeps track of physical activity during the walk by counting the numbers of steps. **Test:** - The user wears the activity tracker and starts walking - The user wears the Stat-on device - The activity tracker activates the daily step counter - The Stat-on device starts monitoring motor symptoms - The technician checks the accuracy of data sent by sensors - The technician checks the database entries to verify the correct storage of data by the system

Adjustment: this test case cannot be implemented as described due to the swap in the device used: AngelCare, a real-time fall detector has been considered not necessary by the medical team and has been replaced by STAT-ON, a Parkinson Holter device. This device does not stream data; it registers information in its internal memory and once per week a summary of Parkinson indicators is downloaded.

Considering that devices are not compatible; the test scenario has to be reformulated and split in two:

1) Acquire and analyse motor symptoms once per week

2) Keep track of the activity using the number of steps. This second subcase is already tested PD A-1 Home-based Motor Activities, Services: DS-1 Location of the patient in the house and home activity/inactivity monitoring, Requirement: R2-6 Activity monitoring

Services: **CS2 Health status**	*Requirement*: **R5-5 Health status**
	Context: When the user goes back home, the VC provides the report of the physical activity just performed (number of steps, time of physical activity). **Test:** *Already tested in SD A-2 Coaching for an active lifestyle, Services:* CS-2 Health status, *Requirement:* R5-5Health status

Services: **SS3 Standby**	*Requirement*: **R3-11 Standby mode**
	Context: The user has visitors at home and wants to put the VC into the sleeping mode for an hour. **Test:** *(An hour is a pseudo realistic time lapse but, in the test, it will be possible to use a shorter time lapse e.g. 5 minutes)* - The user asks the avatar to put in standby mode for 5 minutes - The technician verifies that the avatar understands a command 'idle' and pauses the system for 5 minutes

<u>Test documentation:</u>

Integration:

The test involves the avatar base UI on the tablet, the dialog manager, the standby service (SS3) and the notification manager as part of CS6. The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is switching of the standby mode of the system after a 5mins period.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The system is in active mode and set to standby by a user. The message flow for this test is depicted in Figure 69.

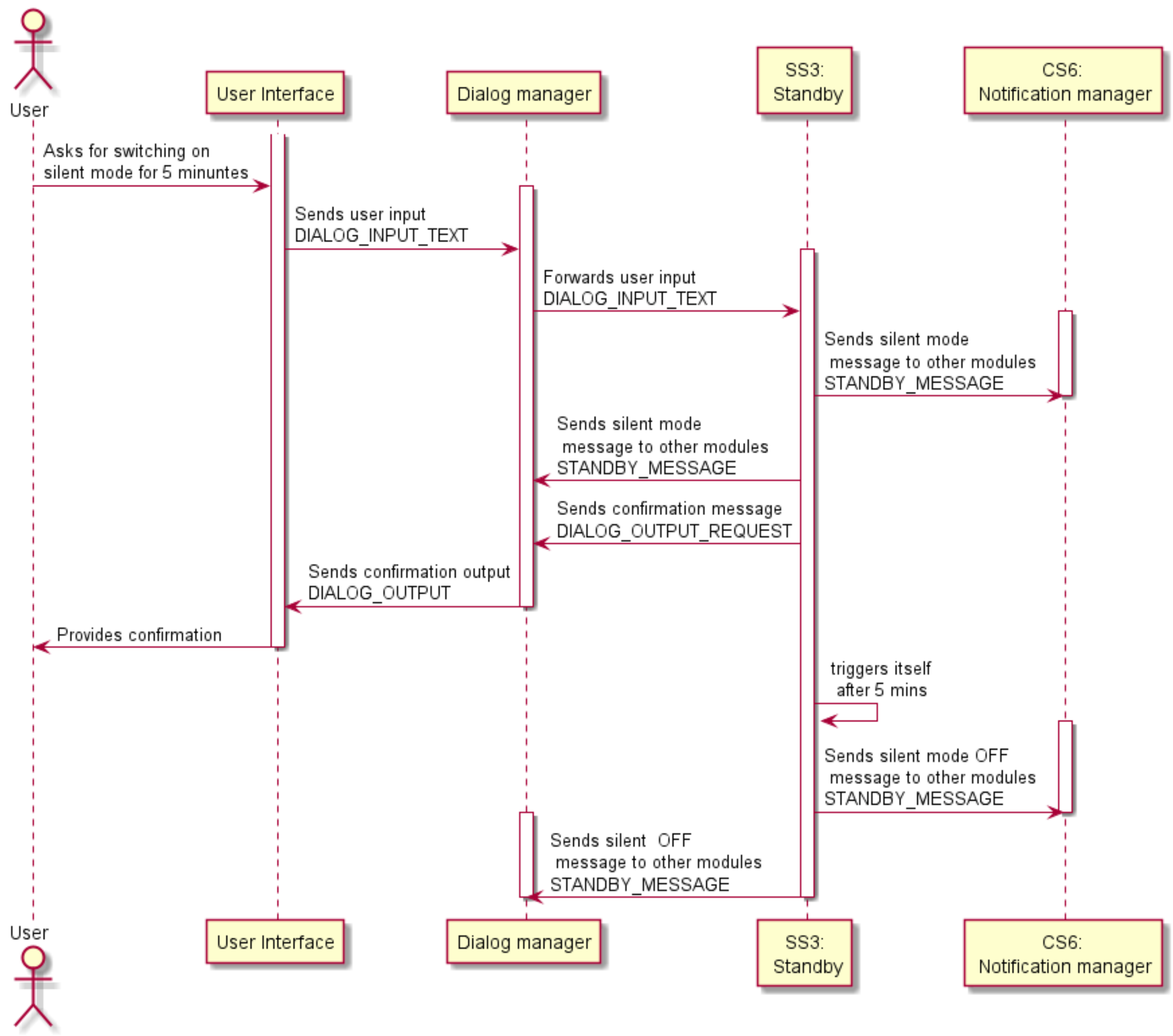

Figure 69: Data flows for test A-2 PD – CS6 – R5-3

Test execution:

- **Trigger**: a technician at AIT triggers the standby mode via the UI
  - **Integration test:** the message flow through all components was tested.
  - **Interaction test:** It is tested if the confirmation of the UI has been shown on the UI

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)

The input is the verbal command "Switch to standby mode" to trigger the standby mode.	Output is the STANDBY_MESSSAGE with the flag OFF automatically triggered after 5min in standby mode.	Clinicians are satisfied; the test reflects their expectations.

Test summary:
We validated the technical components in an integrated environment at the AIT TechLab. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 69 were supervised by technical people by help of the log files. The responses on the UI were monitored visually.

7.2.3 Test case Activity A-3 PD: E-learning

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
E-Learning	CS-4	R5-2
Detection of activities of daily living	DS-7	R2-8, R2-9
Agenda	SS-2	R3-1, R3-7
Standby	SS-3	R3-11

Test case

<table>
<tr><td colspan="2">Activity: E-LEARNING
(TEST 1: RISK FACTOR MODIFICATION)</td></tr>
<tr><td colspan="2">Initial setting (from D1.3): As part of the First narrative/Use Case #5 and #6, Mr. Alvarez profile's at discharge from the hospital composed by

ONTOLOGY (from D1.3/D4.2):
– "Patient profile": pathology (e.g. PD), clinical data depicting the clinical syndrome, clinical classification of patient at discharge (e.g. "Faller")
– "Evidence Indicators": Educational and e-learning time spent.
– "Activity": Supervision of risk behaviour
– "Time Event": free (no predefined schedule)

REASONER (from D1.3):
– Rules for increase patient's knowledge to improve behaviour/reduce risks (Rules D1.3 pg. 63, [Use Case: UC5 and 6 Linked Measure: home environmental monitoring (room and time in room) fall risk])

TECHNOLOGY from (D7.2):
– Tablet
– Object detector</td></tr>
<tr><td rowspan="2">Services: SS2 Agenda</td><td>Requirement: R3-7Agenda interface</td></tr>
<tr><td>Context:
The user asks the VC to consult the agenda in order to carry out the established activity.

Test:

Already tested in SD A-1 Home-based Motor Activities, Services: SS-2 Agenda, Requirement: R3-7 Agenda interface</td></tr>
<tr><td rowspan="2">Services: DS-7 Detection of activities of daily living</td><td>Requirement: R2-9 Deviation behaviour detection</td></tr>
<tr><td>Context:
The VC detected during the past days that the user was not walking indoor with the prescribed aid. Therefore, it provides the user with an e-learning lesson concerning the risk of falling at home and suggests it to the user.

Test:
Already tested in SD A-3 E-Learning, Services: DS-7 Detection of activities of daily living, Requirement: R2-9 Deviation behaviour detection</td></tr>
<tr><td rowspan="2">Services: CS-4 E-Learning</td><td>Requirement: R5-2 E-learning</td></tr>
<tr><td>Context:
The avatar displays on screen an announce by voice what is the next scheduled activity on the agenda: "Health education in PD will start in an hour after taking the medication".

Test:</td></tr>
</table>

	Already tested in SD A-3 E-Learning (Test 1: Risk factor modification), Services: CS-4 E-Learning, *Requirement*: R5-2 E-learning

<table>
<tr><td colspan="2">Activity: E-LEARNING
(TEST 2: PHYSICAL THERAPY)</td></tr>
<tr><td colspan="2">Initial setting (from D1.3): As part of the First narrative/Use Case #5 and #6, Mr. Alvarez profile's at discharge from the hospital composed by

ONTOLOGY (from D1.3/D4.2):

– "Patient profile": pathology (e.g. PD), clinical data depicting the clinical syndrome, rehabilitation goals for the body district to be recovered (e.g. upper limbs)
– "Clinical State": UPDRS-III
– "Evidence Indicators": adherence to motor rehabilitation programme, educational and e-learning time spent, VAS-F
– "Activity": session of e-learning lessons as an alternative to physical rehabilitation treatment
– "Time Event": free (no predefined schedule)

REASONER (from D1.3):

– Rules for increase patient's knowledge to improve game performance/behaviour/reduce risks (Rules D1.3 pg. 63, [Use Case: UC5 and 6 Linked Measure: home environmental monitoring (room and time in room) fall risk])

TECHNOLOGY from (D7.2):

– Sensor based training system (REHABILITY)
– Tablet</td></tr>
<tr><td rowspan="2">Services: SS2 Agenda</td><td>Requirement: R3-1 Coach main interactive application, the avatar</td></tr>
<tr><td>Context:
The avatar through direct verbal interaction with the user asks the patient if he wants to know what upcoming activities are scheduled in his agenda for today. The VC asks the user if he wants to begin his scheduled motor rehabilitation session through serious games now. The user rejects, his arm is painful. Therefore, the avatar proposes, as an alternative tool foreseen in the clinical pathway, a series of e-learning lessons about mobility of the upper limbs.
The user accepts.

Test:

Already tested in SD A-3 E-Learning, Services: SS-2 Agenda, Requirement: R3-1 Coach main interactive application, the avatar</td></tr>
<tr><td rowspan="2">Services: CS-4 E-Learning</td><td>Requirement: R5-2 E-learning</td></tr>
<tr><td>Context:
The VC starts the suitable content on physical activity for the upper limbs and plays it on a tablet.

Test:</td></tr>
</table>

	Already tested in SD A-3 E-Learning (Test 2: Physical therapy), Services: CS-4 E-Learning*, Requirement*: R5-2 E-learning

7.2.4 Test case Activity A-5 PD: Fun supporting activities

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Health status	CS-2	R5-5
Rehabilitation coach	CS-5	R3-6, R4,6
Intelligent notifications scheduler	CS-6	R2-7, R2-8, R3-1, R3-6, R5-3, R5-4
User Feeling	CS-8	R5-6
Standby	SS-3	R3-11

Test case

<table>
<tr><th colspan="2">Activity: FUN SUPPORTING ACTIVITIES</th></tr>
<tr><td colspan="2">Initial setting (from D1.3): As part of the First narrative/Use Case #5 and #6, Mr. Alvarez profile's at discharge from the hospital composed by

ONTOLOGY (from D1.3/D4.2):
– “Patient profile”: pathology (e.g. PD), clinical data depicting the clinical syndrome
– “Evidence Indicators”: user liking, activity duration
– “Activity”: Cognitive leisure activity
– “Time Event”: free (no predefined schedule)
– “Assessment Documents”: the VC system sends a concise report (document) to the neuropsychologist

REASONER (from D1.3):
– monitoring of indoor motor inactivity (Rules D1.3 pg. 58, [Use Case: UC5 and UC6 Linked Measure: Time of Inactivity [min], period, without interruptions, in which patient remains in the same position (no step performed)].
– Rules to identify apathy symptoms (Rules D1.3 pg. 62, [Use Case: UC6. Linked Measure: apathy symptoms: LARS scale).

TECHNOLOGY from (D7.2):
– Tablet
– Activity tracker
– Presence sensor
– STAT-ON</td></tr>
<tr><td rowspan="2">Services: CS6 Intelligent notifications/scheduler</td><td>Requirement: R3-1Coach main interactive application, the avatar.</td></tr>
<tr><td>Context: The avatar through direct verbal interaction with the user asks the patient if he wants to know what upcoming activities are scheduled on his agenda for today or if he wants to perform different activities.</td></tr>
</table>

	Test: – The VC generates a notification to ask the user if he wants to check the agenda and start the activity scheduled or to perform a different activity foreseen by the clinical pathway – The user choses a different activity – The technician verifies the reception of the information by checking the database – The technician checks the logfiles to verify that IF the user wants to perform a different activity, THEN the VC proposes one of the *fun supporting activities:* dancing class

Test documentation:

Integration:

The test involves the avatar base UI on the tablet, the dialog manager, the KRF and the reminder service (CS6). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of the selected activity by the KRF.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 70 below.

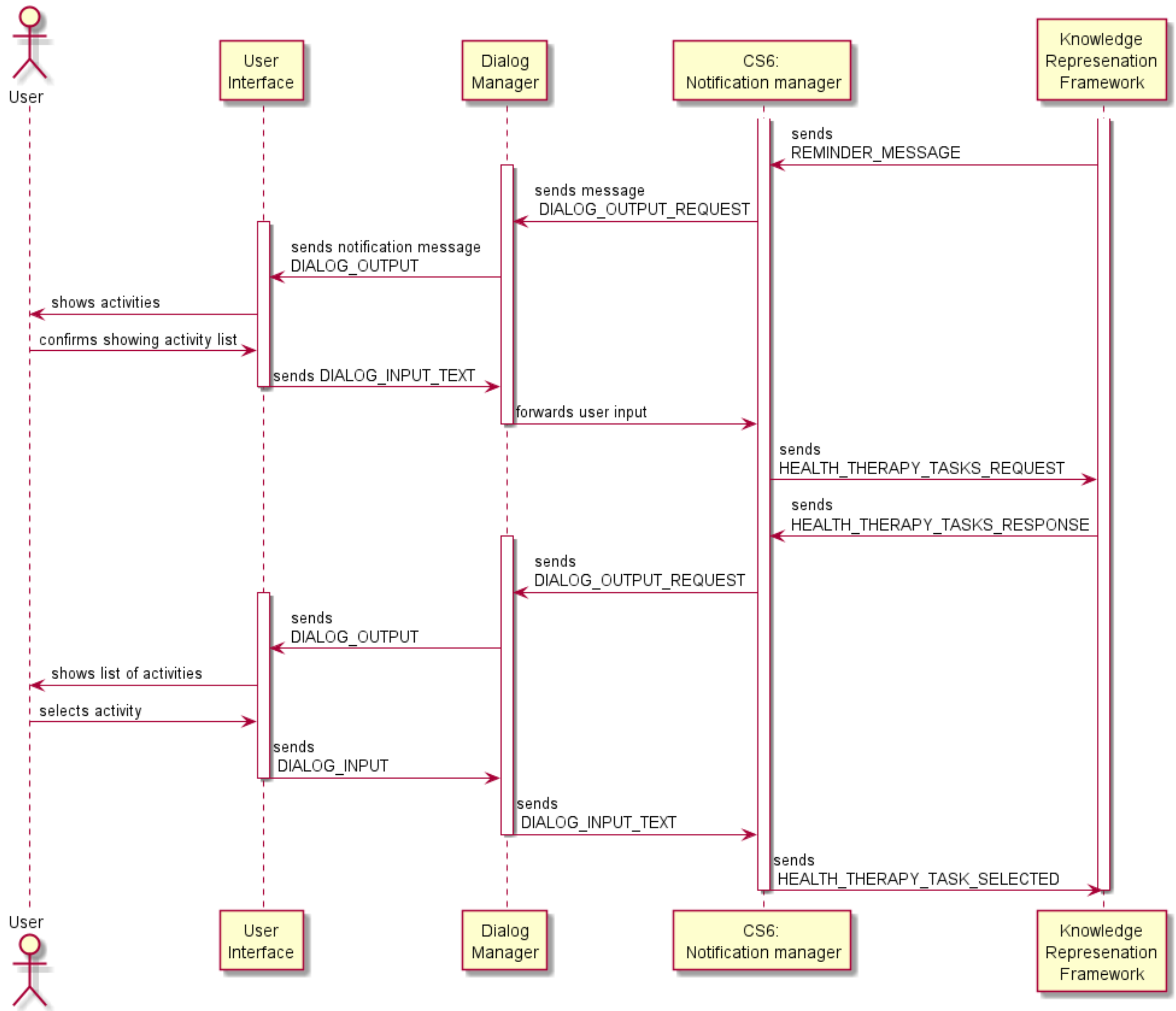

Figure 70: Data flows for test A-5 PD – CS6 – R3-1

Test execution:

- **Trigger**: a technician at FZI triggers a reminder for checking the agenda of activities scheduled for today.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** It is tested if the reminder and the list of activities is shown on the UI

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)

A reminder message is triggered manually at the KRF. After confirmation, a list of upcoming activities as defined in the pathway is requested from the KRF by sending a HEALTH_THERAPY_TASKS_REQUEST Message.	The output is the selected task in the HEALTH_THERAPY_TASK_SELECTED message sending the selected activity back to the KRF.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT tech lab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 70 were supervised by technical people by help of the log files.

Services: **CS6 Intelligent notifications/scheduler**	*Requirement:* **R2-8 Home behaviour monitoring**
	Context: VC detects the daily routines of the users and it detects that the user Tuesdays and Thursdays at 6:00 pm usually go out (to dance classes), but today is Tuesday 6:15 pm and is still at home. VC sends the user a reminder to prepare himself for going to class. **Test:** – Already tested in SD A-3 E-Learning, Services: DS-7 Detection of activities of daily living, Requirement: R3-7 Agenda interface.
	Requirement: **R5-3 Notification and reminders**
	Context: The VC sends a verbal message and a reminder through the application on the tablet that it is time to go to the dance class. If the user does not accept of cancel the message, the VC will send another message after 10 minutes. **Test:** - *Already tested in PD A-2 Coaching for an active lifestyle, Services:* CS6 Intelligent notifications/scheduler*, Requirement:* R5-3 Notification and reminders
	Requirement: **R2-7 Home inactivity detection**
	Context: Half an hour later (6:30 pm), the user is inactive on the couch. **Test:**

	- *Already tested in SD A-1 Home Based motor activities, Services: CS-6 Intelligent notifications, Requirement: R2-7 Home inactivity detection.*
	Requirement: **R4-6 Personalized and context-aware interaction and feedback**
	Context: The VC detects that the user is in front of the TV inactive and suggests going to the dancing class or performing another activity inside or outside. **Test:** - The technician checks the logfiles to verify that at the 5th minute the VC activates a sound alarm inviting the user to go enjoy the dance class or to perform another activity

Test documentation:

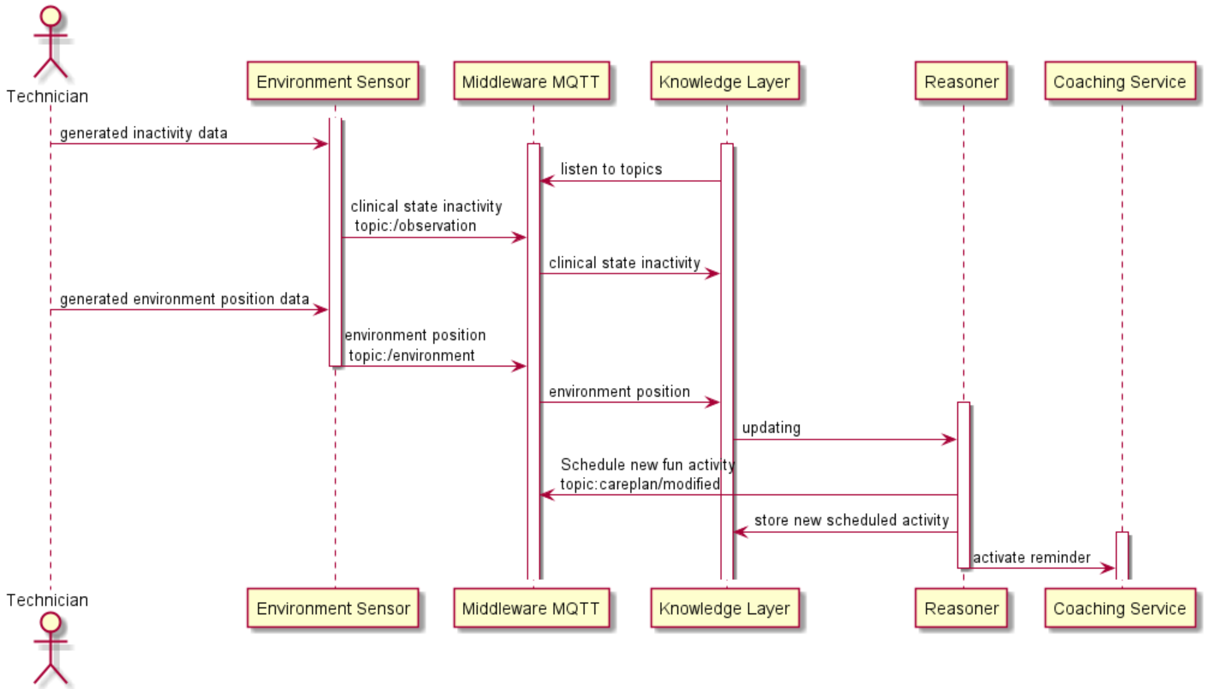

Figure 71: Data flows for test A-5 PD – CS6 – R4-6

Integration:

The interface to integrate the personal and clinical state for a patient is defined and validated.

After processing the information stored in the reasoner according to the definition in the use case the framework then proposes a new scheduled activity to be added to the patients care plan for this day.

The result of this process is similar to *Activity A-5 SD: Fun supporting activities, Services: CS5 Rehabilitation coach, Requirement: R4-6 Personalized and context-aware interaction and feedback.* The reasoner creates a modification of an individual care plan by adding a new scheduled activity (as defined in **D6.4**) to the care plan. Since this technical component is validated in an integrated environment the information is provided to the central middle ware server via the MQTT broker to the topic "vcare/<<patientId>>/careplan/modified".

Test setup - precondition:

- Technical partners generate exemplary clinical state attributes of a patient's inactivity
- Integration tests on processing the state attributes of a patient
- Simulated knowledge about activities foreseen in the care plan inserted to the knowledge layers RDF-store
- Integrated tests on proposing activity

Test execution:

- **Integration test:** messages holding information about the patient's inactivity via the MQTT broker are send to the MQTT broker
- value of inactivity is stored in the knowledge layer related to the simulated patient
- **Trigger:** receiving messages about a patient inactivity via MQTT broker. Message to the topic of "vcare/<patientid>/observation"
- **Reasoner:** automatically searches care plan for activities to be scheduled in the care plan

Test validation:

- the reasoner compares the current state of the patient received by the MQTT broker to the threshold values defined for inactivity in front of the TV (5 min)
- the reasoner generates a new scheduled activity as defined in the ontology (**D4.3**) and provides this information to the topic of the patient's individual care plan
- VC checks the topic "vcare/<<patientId>>/careplan/modified" at CS6 to generate a reminder to be shown on the UI with audio signal

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
Message reporting the patients inactivity for 5 min in front of the TV is send to the Reasoner	The output is adjusting the individual care plan by scheduling an additional activity and publish this information to /careplan/modified	long-term personalization of a care plan can be included in this use case

Test summary:

This use case test forms an important basis for the long-term personalization of a clinical pathway.

It is about processing of existing information about an individual clinical pathway in Knowledge Layer on the one hand and about processing relevant information about the patient current state on the other hand. While we were able to show in this test that the patient's inactivity is processed accordingly, the long-term personalization of a care plan can be included in this use case. This means that instead of suggesting a random activity from the individual care plan the smart agent will learn to detect activities that the patient favours.

Services: **CS5 Rehabilitation coach**	*Requirement:* **R3-6 Information interface**
	Context: The avatar displays on the tablet an announcement by voice to perform an active activity such as going for a walk, go to play cards with his friends or go to dancing classes. **Test:** - The VC asks the user to choose from a list of options which one prefers. - The user chooses one of the proposed activities - The technician verifies that the correct choice was stored into the database

<u>Test documentation:</u>

Integration:

The test is similar to the test A-5 PD – C6 and involves the avatar base UI on the tablet, the dialog manager, the KRF and the notification manager (CS6). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of the selected activity by the KRF.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 72 below.

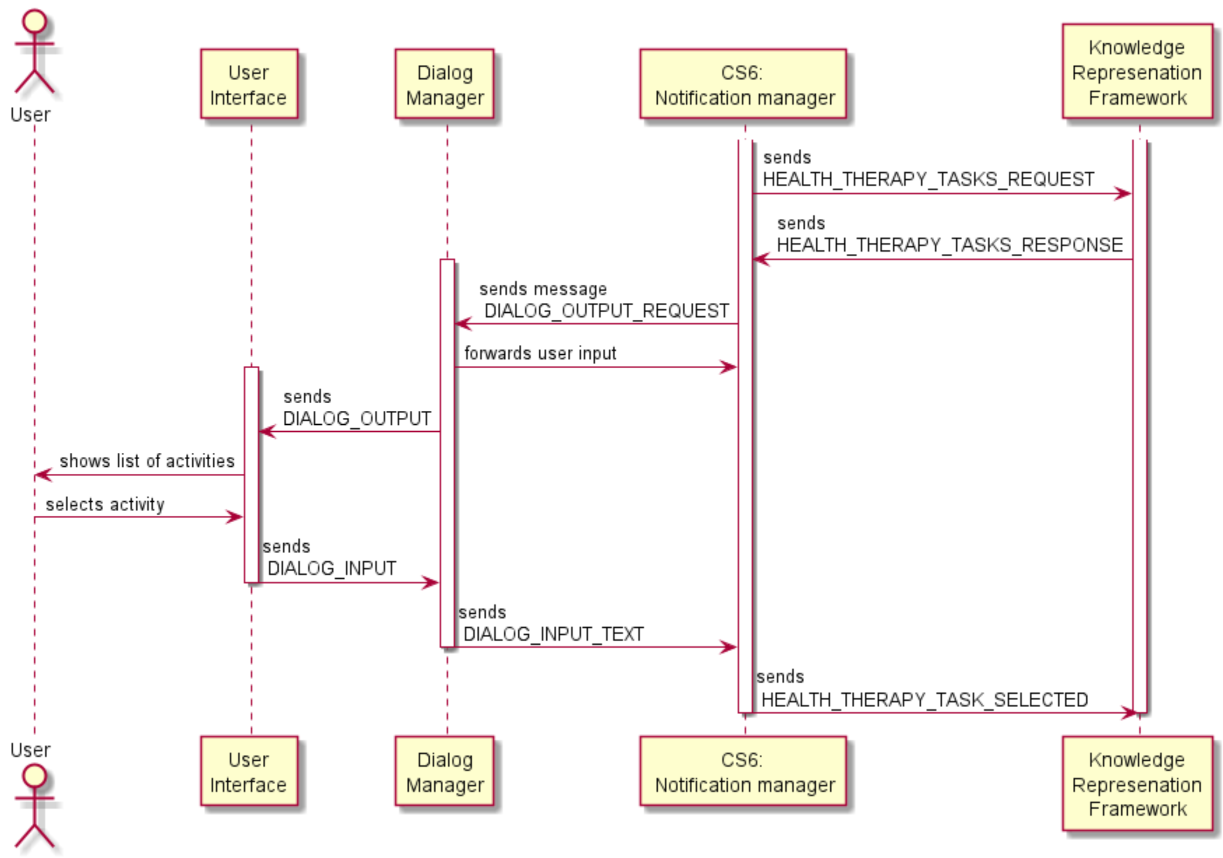

Figure 72: Data flows for test A-5 PD – CS5[14]

Test execution:

- **Trigger**: a technician at AIT triggers the request for a list of activities for the current day to be provided by the KRF
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** It is tested if the list of activities shown on the UI

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)

[14] NOTE: CS5 is not involved here, the use case is instead covered by CS6

A HEALTH_THERAPY_TASKS_REQUEST message is triggered manually within CS6 and a list of upcoming pathway related activities is displayed on the UI	The output is the HEALTH_THERAPY_TASK_SELECTED message holding the selected task.	Clinicians are satisfied; the test reflects their expectations.

Test summary:
We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 72 were supervised by technical people by help of the log files.

Services: **CS8 User feeling**	*Requirement:* **R5-6 User feelings**
	Context: VC asks questions to the user regarding its subjective wellbeing, scoring with a 5-points Liker scale. **Test:** *Already tested in SD A-2 Coaching for an active lifestyle, Services:* CS-8 User feeling, *Requirement:* R5-6 User feelings
Services: **CS2 Health status**	*Requirement*: **R5-5 Health status**
	Context: The VC at the end of the activity reports and compares results with the expected goals and overall personal best performance. **Test:** *Already tested in SD A-5Fun supporting activity, Services:* CS-2Health status, *Requirement:* R5-5 Health status
Services: **SS3 Standby**	*Requirement:* ***R3-11 Standby mode***
	Context: The user has visitors at home and wants to put the VC into the sleeping mode for an hour. When the hour is passed, the VC will be on automatically **Test:** *Already tested in PD A-2Coaching for an active lifestyle, Services:* SS-3Standby mode, *Requirement:* R3-11 Standby mode

7.2.5 Test case Activity A-9 PD: Monitoring pain and sleep

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Medical questionnaires	CS-7	R5-7
Agenda	SS-2	R3-1, R3-7
Standby	SS-3	R3-11

Test case

<table>
<tr><td colspan="2">Activity: MONITORING PAIN AND SLEEP</td></tr>
<tr><td colspan="2">Initial setting (from D1.3): As part of the First narrative/Use Case #5 and #6, Mr. Alvarez profile's at discharge from the hospital composed by:

ONTOLOGY (from D1.3/D4.2):
– "Patient profile": pathology (e.g. PD), clinical data depicting the motor symptoms.
– "Clinical State": sleep questionnaires.
– "Evidence Indicators": Parkinson's Disease Sleep Scale (PDSS) and Epworth Somnolence Scale (ESS).
– "Activity": monitoring sleep through questionnaires.
– "Time Event": Before starting the cognitive training (3 days/week)
– "Assessment Documents": report (document) with psychological questionnaires performed at the clinic.

REASONER (from D1.3):
– Rules to identify and improve manifestations associated to emotional (depression) and motivational (apathy) problems (Rules D1.3 pg. 61, [Use Case: UC5 and UC6. Linked Measure: emotive status recognition (emotion/mood).
– Rules to provide positive message (Rules D1.3 pg. 62, [Use Case: UC5 and UC6. Linked Measure: emotive status recognition (emotion/mood).

TECHNOLOGY from (D7.4):
– Machine learning
– Voice tone recognition
– Tablet</td></tr>
<tr><td rowspan="2">Services: SS2 Agenda</td><td>Requirement: R3-7 Agenda interface</td></tr>
<tr><td>Context:
The user asks the VC to consult the agenda in order to carry out the established activity.

Test:

Already tested in SD A-1 Home-based Motor Activities, Services: SS-2Agenda, Requirement: R3-7Agenda interface</td></tr>
<tr><td>Services: SS2 Agenda</td><td>Requirement: R3-1 Coach main interactive application, the avatar</td></tr>
</table>

	Context: The user asks to know what upcoming activities are scheduled in his agenda for today through direct interaction with the avatar **Test:** *Already tested in SD A-1 Home-based Motor Activities, Services:* SS-2 Agenda, *Requirement:* R3-1 Coach main interactive application, the avatar
Services: **CS7 Medical questionnaires**	*Requirement:* **R5-7 Questionnaires**
	Context: The avatar displays on the screen and verbally the specific sleep questionnaires: PSSS and ESS. VC collects the data and analyses the results comparing them to the baseline. If the results are normal, VC will motivate the user to continue with the rest of the activities. **Test:** *Already tested in* PD A-8 Monitoring mood, Services: CS7 Medical questionnaires, *Requirement:* R5-7 Questionnaires
Services: **SS3 Standby**	*Requirement*: ***R3-11 Standby mode***
	Context: The user has visitors at home and wants to put the VC into the sleeping mode for an hour. When the hour is passed, the VC will be on automatically **Test:** *Already tested in PD A-2 Coaching for an active lifestyle, Services:* SS-3 Standby mode, *Requirement:* R3-11 Standby mode

7.2.6 Test case Activity A-11 PD: Falls prevention

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Fall detection	DS-4	R2-5

Test case

Activity: FALLS PREVENTION
Initial setting (from D1.3): As part of the First narrative/Use Case #5 and #6, Mr. Alvarez profile's at discharge from the hospital composed by: **ONTOLOGY** (from D1.3/D4.2): – "**Patient profile**": pathology (e.g. PD), clinical data depicting the motor symptoms, VC platform goal is to prevent falls

<table>
<tr><td colspan="2">
– “Clinical State”: UPDRS
– “Evidence Indicators”: UPDRS and Sense4care device (STAT-ON)
– “Activity”: monitoring through the sense4care device the motor symptoms
– “Time Event”: continuously monitor
– “Assessment Documents”: report (document) with the output recorded for1 week

REASONER (from D1.3):

– Rules to quantify fall risk (high, intermediate or low risk) and prevent falls (Rules D1.3 pg. 57, [Use Case: UC5 and UC6. Linked Measure: OFF period time [min]/day and ON period time [min]/day (Sense4care), Number of Freezing of Gate episodes /day (Sense4care), Number falls/day (Sense4care)
– Rules to reduce manifestations and risks (falls) associated to orthostatic hypotension (Rules D1.3 pg. 60, [Use Case: UC5. Linked Measure: orthostatic hypotension (OH) (continuous blood pressure sensor and gyroscope) to manage feedback.

TECHNOLOGY from (D7.4):

– Sense4care: STAT-ON
</td></tr>
<tr><td rowspan="2">Services: DS-4 Fall detection</td><td>Requirement: R2-5 VC detects falls.</td></tr>
<tr><td>Context:
The Sense4care device (STAT-ON) provides the fall detection of the patient. The device is linked with the user’s phone and it collects and analyses all the information related to motor symptoms. First, the monitor device must be installed in the phone of the user and the App connects to the STAT-ON device by Bluetooth. Once it is configured, the patient must wear the device within a belt and put on the belt with the sensor placed at the left side of the waist above the iliac crest.

Test:

- The user puts on the device within a belt and starts walking
- The device records information about motor activity, the severity of motor symptoms and detects falls.
- The technician verifies the accuracy of data sent by the device via Bluetooth and the reception of data by checking the database entries
- The technician checks the logfiles to verify the generation of a report for results consultation
</td></tr>
</table>

Adjustment: the fall detection has been considered as non-necessary by the medical team and the corresponding sensor (AngelCare) will not be integrated. Therefore, test cases related to requirement R2-5 cannot be executed. Instead, the Stat-On fall sensor will be used. This has a differing reporting period. Thus, an updated test scenarios will be outlined and reported in the course of the LivingLab.

7.2.7 Test case Activity A-15 PD: Medication intake support

Services and Requirements enhancing the Activity.

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Intelligent notifications scheduler	CS-6	R2-7, R2-8, R3-1, R3-6, R5-3, R5-4
Agenda	SS-2	R3-1, R3-7

Test case

<table>
<tr><th colspan="2">Activity: MEDICATION INTAKE SUPPORT</th></tr>
<tr><td colspan="2">Initial setting (from D1.3): As part of the First narrative/Use Case #5 and #6, Mr. Alvarez profile's at discharge from the hospital composed by:

ONTOLOGY (from D1.3/D4.2):

– "Patient profile": pathology (e.g. PD), clinical data depicting the motor symptoms.
– "Clinical State": UPDRS
– "Evidence Indicators": UPDRS and Sense4care device (STAT-ON)
– "Activity": remind the patient to take the medication and verify that medication is taking through monitoring the motor symptoms and the ON-OFF state with the sense4care device.
– "Time Event": continuously monitor
– "Assessment Documents": report (document) with the output recorded daily.

REASONER (from D1.3):

– Rules to reduce OFF time, avoid risky activities during OFF periods (prevent falls) and prevent from
performing serious games. (Rules D1.3 pg. 56, [Use Case: UC5 and UC6. Linked Measure: OFF period time [min] /day (period, without interruptions, in which patient remains in poor motor situation) (Sense4care)
– Rules to monitor indoor motor inactivity (Rules D1.3 pg. 58, [Use Case: UC5 and UC6. Linked Measure: Time of Inactivity [min], period, without interruptions, in which patient remains in the same position (no step performed)

TECHNOLOGY from (D7.4):

– Sense4care: STAT-ON
– Pillbox</td></tr>
<tr><td rowspan="2">Services: SS2 Agenda</td><td>Requirement: R3-7 Agenda interface</td></tr>
<tr><td>Context:
The user asks the VC to consult the agenda of the medication intake in order to take the medication stablished.

Test:</td></tr>
</table>

	Already tested in SD A-1 Home-based Motor Activities, Services: SS-2 Agenda, *Requirement:* R3-7 Agenda interface
Services: **CS6 Intelligent notifications/scheduler**	*Requirement:* **R2-8 Home behaviour monitoring**
	Context: VC detects that at 9:00am the user has not taken the medication as scheduled. **Test:** - Pseudo data are used to simulate the scheduled medication intake and the current day time: 9.00am - The user does not take the pills from the pillbox - The technician checks the database to verify that the system stores the information that "the user has not taken the pills"

Adjustment: The medication monitoring device has been disregarded because the alternatives found are not cost-effective. The medical team decided that a survey-based strategy through the avatar would be similar in terms of measuring medication compliance. (see 2.4).

As a collateral, the integration of the medication sensor will not be available and therefore, the current testcase needs reformulation.

Services: **SS2 Agenda**	*Requirement:* **R3-1 Coach main interactive application, the avatar**
	Context: The avatar through direct verbal interaction with the user reminds the patient to take the medication as it is scheduled. The user accepts. **Test:** - The avatar reminds the user to take the medication - The user accepts. - The technician checks the database to verify the storage of the positive answer provided by the user

<u>Test documentation:</u>

Integration:

The test involves the avatar base UI on the tablet, the notification manager service (CS6), die dialog manager and the reasoner. The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of the reminder for medication intake by the end-user UI on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 73.

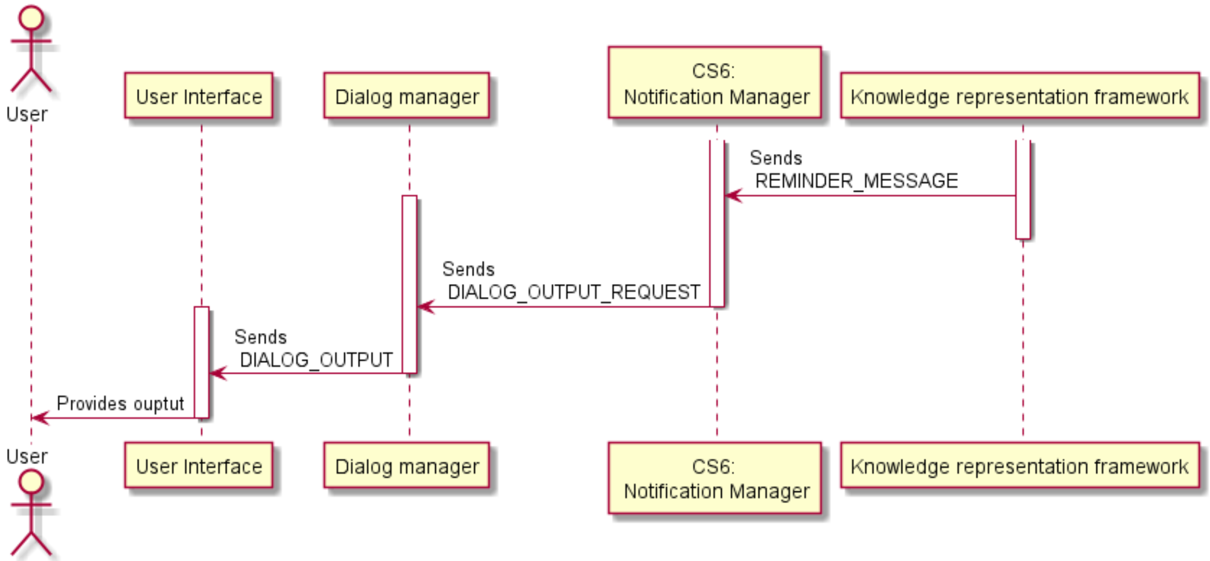

Figure 73: Data flows for test A-15 PD – SS2[15]

Test execution:

- **Trigger:** the reminder is triggered by the KRF manually for the test.
  - **Integration test:** the message flow through all components was tested.
  - **Interaction test:** The reminder has been shown on the tablet via speech output and a textual reminder message.

Test validation:

  - The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
The Input is a manually generated REMINDER_MESSAGE sent by the KRF	The output is the message presented to the user in verbal and textual form.	Clinicians are satisfied; the test reflects their expectations.

[15] Note: the reminder is triggered by the KRF

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 73 were supervised by technical people by help of the log files.

Services: **CS6 Intelligent notifications/scheduler**	*Requirement:* **R2-7 Home inactivity detection**
	Context: Half an hour has passed, and the user has not yet taken the medication scheduled. The VC generates a notification to the user to invite him to go where the medication is and reminds him to take the pills. **Test:** *(30 minutes is a pseudo realistic time lapse but, in the test, it will be possible to use a shorter time lapse e.g. 5 minutes)* - The activity tracker is not giving 'active' levels for 5 minutes from the remainder - The technician verifies that the time recorded in the database corresponds to 5 minutes. - The technician checks the logfiles to verify that at the 5th minute the VC activates a sound alarm remanding the user to take the medications

Adjustment: The medication monitoring device has been disregarded because the alternatives found are not cost-effective. The medical team decided that a survey-based strategy through the avatar would be similar in terms of measuring medication compliance.

As a collateral, the integration of the medication sensor will not be available and therefore, the current testcase needs reformulation.

Services: **CS6 Intelligent notifications/scheduler**	*Requirement:* **R3-6 Information interface**
	Context: The user is still in his room and has not yet taken the medication scheduled. While the user is still in his room, the VC sends a verbal message through the tablet that is in his room and send a reminder. The user needs to accept it in order to stop the message. If it is not accepted, the VC will send another message after 10 minutes **Test:** - The user doesn't take the medication from the pillbox - The technician checks the accuracy of data sent via Bluetooth from the pillbox

	- The technician verifies that the information "the user has not taken the pillbox" has been stored by checking the database entries - The technician checks the logfiles to verify that, after 10 minutes the first remainder, the VC activates another sound alarm inviting the user to take the medication

Adjustments: according to the decision to discard the use of a pillbox (see 2.4) and use a reminder instead, the message flow has been changed as well. The test reflects the adjusted use case based on a reminder.

Services: **CS6 Intelligent notifications/scheduler**	*Requirement:* **R5-3 Notification and reminders**
	Context: The user has not taken the medication yet. The VC sends a verbal message and a reminder through the tablet that it is time to take the medication. The user needs to accept it in order to stop the message. If it is not accepted, the VC will send another message after 10 minutes **Test:** *Already tested in PD A-2 Coaching for an active lifestyle, Services:* CS6 Intelligent notifications/scheduler, *Requirement:* R5-3 Notification and reminders
Services: **CS6 Intelligent notifications/scheduler**	*Requirement:* **R5-4 Agenda**
	Context: Once the user has taken the medication through the pillbox, the VC sends a positive message to the user informing that the medication is taking correctly as scheduled. In addition, it sends a reminder of the next time to take the medication. **Test:** - The user takes the medication from the pillbox - The technician checks the accuracy of data sent via Bluetooth from the pillbox - The technician verifies that the information "the user has taken the pillbox" has been stored by checking the database entries - The technician verifies that the VC provides the remainder of the next time the user has to take the medication

Adjustments: according to the decision to discard the use of a pillbox (see 2.4) and use a reminder instead, the message flow has been changed as well. The test reflects the adjusted use case based on a reminder and is then equal to the test performed in test case A-15 PD – CS6 for R3-6. Hence, this test can be skipped.

7.3 Activity test Report–Heart Failure

A Test case for each one of the following Activities related to Heart Failure (HF) listed in D1.4 – Annex 6.6 has been defined and will be described henceforth:

Table 25 - List of Activities related to Heart Failure (HF) as listed in D1.4 - Annex 6.6

Activity (A)	**A #**	**Other Paths**	**Medical Use Case UC #**	**Needs**	**Medical Priority (1=high, 4=low)**
E-learning	A-3	SD, PD, IHD	UC1, UC2, UC5, UC6, UC7, UC9, UC10, UC11	Physical therapy, Cognitive training, Risk Factor Modification.	4
Daily motor activity	A-12		UC9	Physical therapy	2
Aerobic physical activity	A-13	IHD	UC9, UC11	Physical therapy	1
Resistance training	A-14	IHD	UC10, UC11, UC13, UC14	Physical therapy	2
Medication intake support	A-15	PD, IHD	UC5, UC7, UC12	Pharmacological intervention	2
Vital stats control	A-16		UC9, UC10	Monitor Vital signs	1
Weight control	A-17	IHD	UC11	Risk Factor Modification	3
Smoking cessation activity	A-18	IHD	UC10, UC14	Risk Factor Modification	3
Anxiety and depression reduction	A-19	IHD	UC7, UC9, UC10, UC13	Emotional and Social rehabilitation	4

7.3.1 Test case Activity A-3 HF: E-learning

Services and Requirements enhancing the Activity

Service Needs (WP5)		**Functional Requirements (WP7)**
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
E-Learning	CS-4	R5-2
Detection of activities of daily living	DS-7	R2-8, R2-9

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Agenda	SS-2	R3-1, R3-7
Standby	SS-3	R3-11

Test case

Activity: E-LEARNING (TEST 1: RISK FACTOR MODIFICATION)
Initial setting (from D1.3): As part of the Second narrative/Use Case #10, Mr. Gheorghe profile's at discharge from the hospital composed by **ONTOLOGY** (from D1.3/D4.2): – "**Patient profile**": pathology (e.g. heart failure), clinical data depicting the clinical syndrome, clinical classification of patient at discharge (e.g. "Smoker") – "**Evidence Indicators**": Educational and e-learning time spent. – **"Activity":** Supervision of risk factor behaviour – **"Time Event":** free (no predefined schedule) **REASONER** (from D1.3): – Rules for increase patient's knowledge to improve behaviour/reduce risks (Rules D1.3 pg. 72, [*Use Case: UC10 and 6 Linked Measure: progressive decrease of smoked cigarettes]*) **TECHNOLOGY** from (D7.2): - Tablet

Services: **DS-7 Detection of activities of daily living**	*Requirements:* **R2-8 Home behaviour monitoring***:* **Context:** The VC detected that today the user hasn't reported the number of cigarettes smoked and displays reminder message on screen. **Test:** - The technician verifies that at the scheduled time the VC displays a message to remind the user to report the number of cigarettes smoked today - User reports the number of cigarettes smoked - The technician checks the database to verify that the number of cigarettes stored corresponds to the number reported by the user

Test documentation:

Integration:

The test involves the avatar base UI on the tablet, the dialog manager, the KRF and the medical questionnaire service (CS7). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of the questionnaire result (number of cigarettes smoked) by the KRF.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 74.

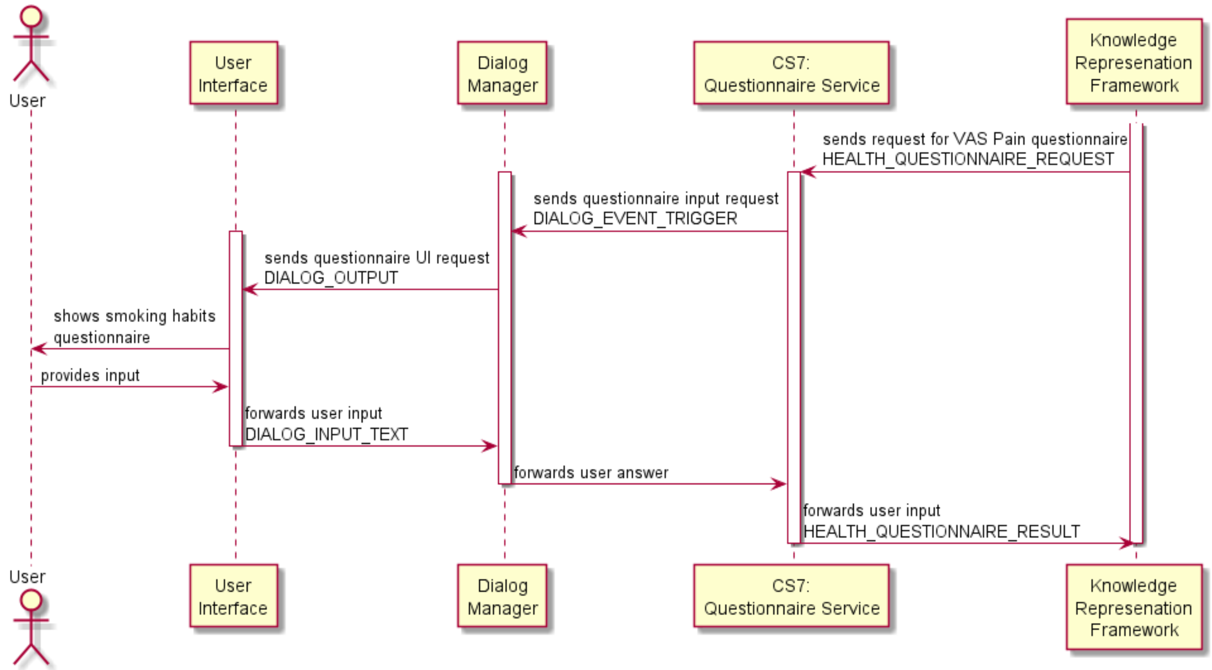

Figure 74: Data flows for test A-3 HF – DS7 – R2-8[16]

Test execution:

- **Trigger**: the KRF triggers the Smoking habits assessment questionnaire.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** The questionnaire is shown on the tablet via speech output and a textual reminder message and the response is received by the reasoner (the KRF)

Test validation:

[16] NOTE: this is realized by the questionnaire module instead of DS7

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
The input is a HEALTH_QUESTIONNAIRE_REQUEST message which is generated manually to trigger the test case.	The output is the result of the questionnaire (number of cigarettes consumed) sent back to the KRF.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT tech lab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 74 were supervised by technical people by help of the log files.

<table>
<tr><td rowspan="2">Services: DS-7 Detection of activities of daily living</td><td>Requirement: R2-9 Deviation behaviour detection</td></tr>
<tr><td>Context:
The VC detected that in the past week the user reported a higher number of cigarettes smoked. The VC reminds the user about the risk of smoking and suggests him an e-learning lesson concerning smoking cessation.

Test:

- Data simulating potential increase of cigarettes intake during the past weekly history are inserted into the system
- The technician verifies that the reasoner acknowledges the potential increase of cigarettes intake by checking for hazard events in the patient risk management chart
- The technician verifies that IF increase of cigarettes intake during past days, THEN the reasoner checks for suitable e-learning contents in the multimedia library

- The technician verifies that the reasoner informs the user that a new e-learning lesson is available in the tablet</td></tr>
</table>

<u>**Test documentation:**</u>

Integration:

The test involves the avatar base UI on the tablet, the dialog manager, notification / reminder module (CS6) and the reasoner (the KRF). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is a reminder message to inform the user about an e-learning session about smoking cessation.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 73 below.

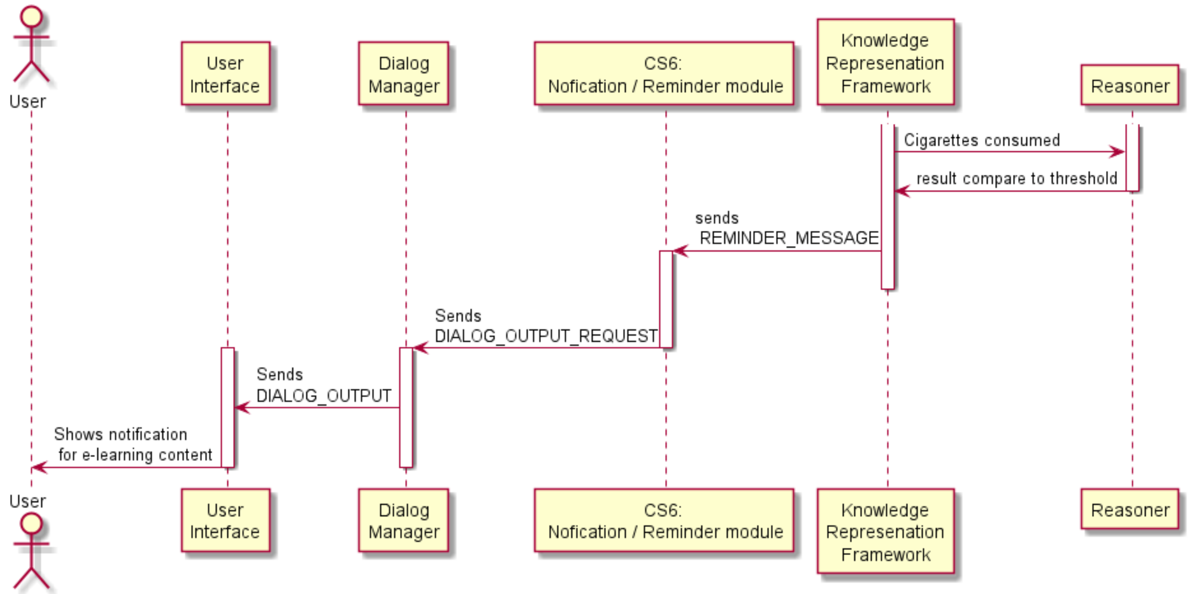

Figure 75: Data flows for test A-3 HF –DS7 – R2-9

Test execution:

- **Trigger:** the reminder is triggered by the KRF manually for the test to be send to the reasoner.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** The reminder has been shown on the tablet via speech output and a textual reminder message and the user can confirm the proposal

Test validation:

- The log of the end-user UI is checked if the notification message could be received.
- The KRF is checked if the trigger has been created correctly

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
Input is a manually triggered by storing threshold value of cigarette consumption in the	A notification message is shown for informing the user to consume e-learning content	Clinicians are satisfied; the test reflects their expectations.

knowledge layer. Number of smoked cigarettes is given by a questioner to the patient	regarding smoking cessation. This message is then presented on the tablet verbally and textually.

Test summary:
We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 73 were supervised by technical people by help of the log files.

Services: **SS2 Agenda**	*Requirement*: ***R3-7Agenda interface***
	Context: The VC includes the e-learning activity in the agenda. **Test:** - The technician checks the logfiles to verify that the system includes e-learning activity in the agenda service

Test documentation:

Integration:

The test involves the avatar base UI on the tablet and the agenda service (SS2) in the backend which is connected to the KIOLA platform (caregiver UI) providing the rehabilitation schedule via a REST interface. The communication between the UI and the agenda service is performed via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of agenda items by the end-user UI on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The data flow or this test is depicted in Figure 76 below.

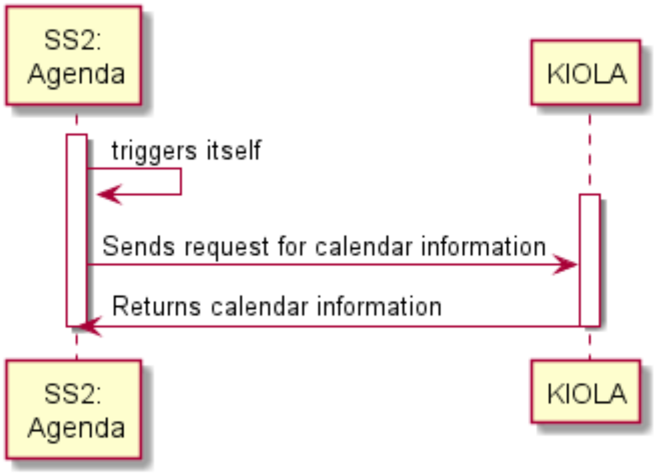

Figure 76: Data flows for test A-3 HF - SS2

Test execution:

- **Trigger:** the agenda service is triggered manually to retrieve the items from the care giver interface
  - **Integration test:** Check, if the response has been received and the list of tasks contains the e-learning activity as expected.

Test validation:

- **The log of the end-user UI is checked if the response could be received.**

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
The input is a manually triggered request to retrieve the pathway calendar information from the KIOLA platform via the rest interface.	Output is the list of calendar items in JSON format.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 76 were supervised by technical people by help of the log files.

Services: **CS-4 E-Learning**	*Requirement*: **R5-2 E-learning**
	Context:

	The user is on the couch. He picks up the tablet and the VC asks if he wants to start the e-learning educational and informative contents for smoking cessation now. User agrees. **Test:** - The technician verifies that IF increase of cigarettes intake during the past days AND IF a suitable e-learning lesson is available, THEN the Virtual Coach asks to the user if he wants to participate in a virtual lesson on "smoking cessation" - The user agrees - The technician checks the database entries to verify the storage of the positive answer - The technician checks the logfiles to verify that IF positive answer, THEN the Virtual Coach unlocks and launches the lesson

Test documentation:

Integration:

The test involves the avatar base UI on the tablet, the dialog manager, the KRF and the e-learning service (CS4). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving the e-learning content by the user on the UI running on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 77.

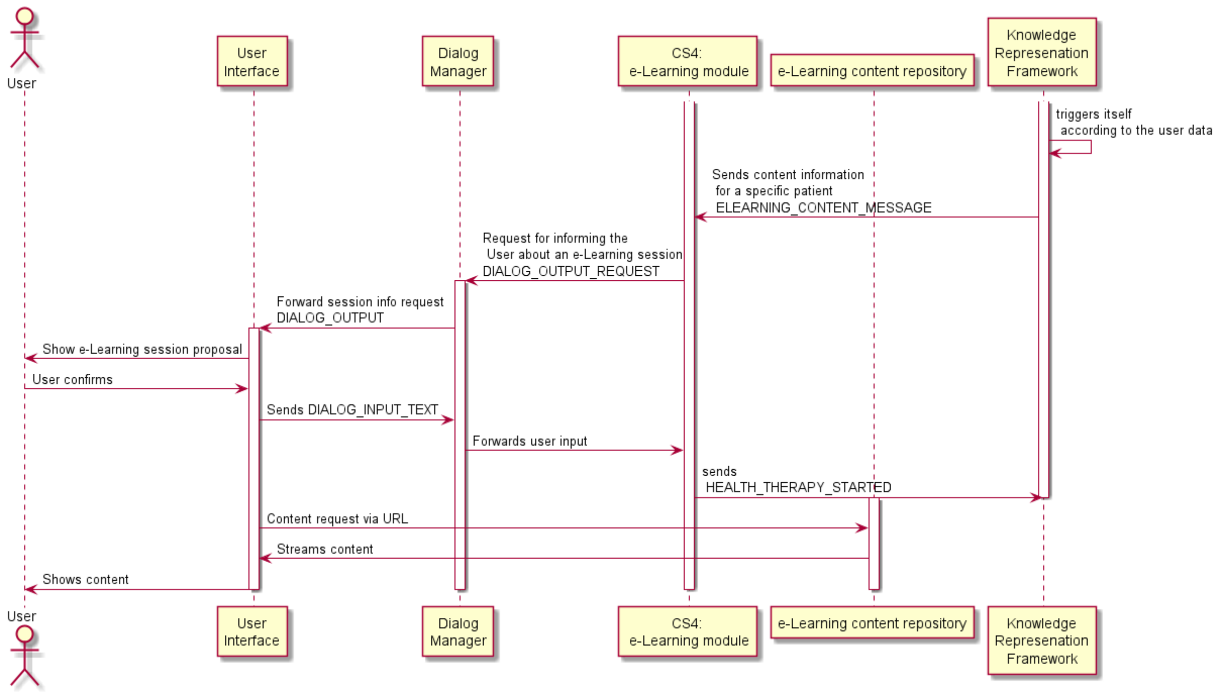

Figure 77: Data flows for test A-3 HF – CS4

Test execution:

- **Trigger**: a technician at FZI triggers the test manually invoking the ELEARNING_CONTENT_MESSAGE sent to the CS4.
  - **Integration test:** the message flow through all components was tested.
  - **Interaction test:** It is tested if the e-learning session is established on the UI.

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
The input is a manually triggered ELEARNING_CONTENT_MESSSAGE sent by the KRF to CS4	Output is the message HEALTH_THERPY_STARTED to notify the KRF that the e-learning session has been started.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 77 were supervised by technical people by help of the log files.

<table>
<tr><td rowspan="2">Services: SS-3 Standby</td><td>Requirement: R3-11 Standby mode</td></tr>
<tr><td>Context:
The user goes to the seaside for a spring holiday and decides not to interact with the VC for that time.

Test:
Already tested in PD A-2 Coaching for an active lifestyle, Services: SS-3 Standby mode, Requirement: R3-11 Standby mode</td></tr>
</table>

7.3.2 Test case Activity A-12 HF: Daily motor activity

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Health status	CS-2	R5-5
Rehabilitation coach	CS-5	R3-6, R4,6
Intelligent notifications scheduler	CS-6	R2-7, R2-8, R3-1, R3-6, R5-3, R5-4
User feeling	CS-8	R5-6
Location + activity monitoring	DS-1	R2-1, R2-6, R2-7
Agenda	SS-2	R3-1, R3-7

Test case

<table>
<tr><th>Activity: DAILY MOTOR ACTIVITY</th></tr>
<tr><td>Initial setting (from D1.3): As part of the First narrative/Use Case #7 and #8,Mrs. Elena profile’s at discharge from the hospital composed by

ONTOLOGY (from D1.3/D4.2):

– “Patient profile”: pathology (e.g. heart failure), clinical data depicting the clinical syndrome
– “Evidence Indicators”: Time spent daily doing motor activity
– “Activity”: Supervision of daily motor activity
– “Time Event”: free (no predefined schedule)
– “Assessment Documents”: report (document) with cardiological instruments at questionnaires performed at the clinic.

REASONER (from D1.3):</td></tr>
</table>

– Rules to improve user's cardiovascular fitness (Rules D1.3 pg. 68, [*Use Case: UC9. Linked Measure: Number of steps*] – Rules to improve user's cardiovascular fitness (Rules D1.3 pg. 68, [*Use Case: UC9. Linked Measure: Aerobic activity sessions: Fast walking/treadmill/cycling*] – Rules to asses user feedback (Rules D1.3 pg. 68, [*Use Case: UC9. Linked Measure: Training efficiency (to manage feedback), assessment of the time spent during phase 2 within the THR*] – Rules to asses user feedback (Rules D1.3 pg. 71, [*Use Case: UC9. Linked Measure: Resistance training game score (to manage Feedback*] – Rules to asses user feedback (Rules D1.3 pg. 68, [*Use Case: UC9. Linked Measure: Game score (to manage game difficulty level*] **TECHNOLOGY** from (D7.2): – Activity tracker – Tablet – Blood pressure monitoring device – Smart-home devices – Sensor based training system (REHABILITY)

Services: **CS2 Health status**	*Requirement:* **R5-5 Health status**
	Context: After taking her morning pills the user decides to start the motor activity session. Before starting the activity session, the VC monitors vital signs. **Test:** - The user wears the activity tracker to measure vital signs before starting the activity - The technician verifies the accuracy of data sent via Bluetooth by the sensor - The technician verifies in the database the correct storage of data

Adjustment: Already tested in HF A-16 VITAL STATS CONTROL, Services: DS-5 Monitoring of vital parameters, Requirement: R7-1 Vital sings monitoring

Services: **CS5 Rehabilitation coach**	*Requirement*: **R3-6 Information interface**
	Context: A scheduled motor activity is due in 30 minutes. The VC informs the user. **Test:** *Already tested in SD A-1 Home-based Motor Activities, Services:*CS-5Rehabilitation Coach*, Requirement:* R3-6Information interface
Services: **CS6 Intelligent notifications/scheduler**	*Requirement:* **R2-7 Home inactivity detection**
	Context: Half an hour has passed and the VC detects that the user hasn't started his chosen training. The smart home system recognizes the user is inactive in his bed.

	Test: *Already tested in SD A-1 Home-based Motor Activities, Services:* CS6 Intelligent notifications / scheduler*, Requirement:R2-7 Home inactivity detection*

	Requirement: **R2-8 Home behaviour monitoring:**
	Context: The Virtual Coach detects patterns in user's daily routine. It detects that is 12:00 and he/she has performed only 50% of the number of steps she usually does by that hour. **Test:** - Data simulating the usual number of steps of the user are inserted into the system - The user wears the activity tracker and performs a certain number of steps - The technician verifies that the system stores the number of steps performed by the user and provides a message with the percentage with respect to usual behaviour -

Adjustment: This test case is a generalization of other cases already tested. E.g., SD, A3: E-learning, Service CS-6: Intelligent notifications, Requirements R2-9: Deviation Behaviour Detection

Services: **CS6 Intelligent notifications/scheduler**	*Requirement:* **R3-6 Information interface**
	Context: The user feels confident about his progress and asks the VC to display his efficiency in performing the rehabilitation exercises during the past week **Test:** - Data simulating the past performances of the user are inserted into the system - The user asks the VC to show him results The technician checks the logfiles to verify that, given the request, the VC shows the user the summary of the performances during the past days

<u>Test documentation:</u>

Integration:

The test involves the avatar base UI on the tablet, the dialog manager, the KRF, the health status service (CS2) and the Motivational message framework of CS5. Since this is triggered by the user, the CS6 is not involved. The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving the health status on request by the user on the UI running on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. For this test, the data of the current activity are entered into the system manually. The message flow for this test is depicted in Figure 78.

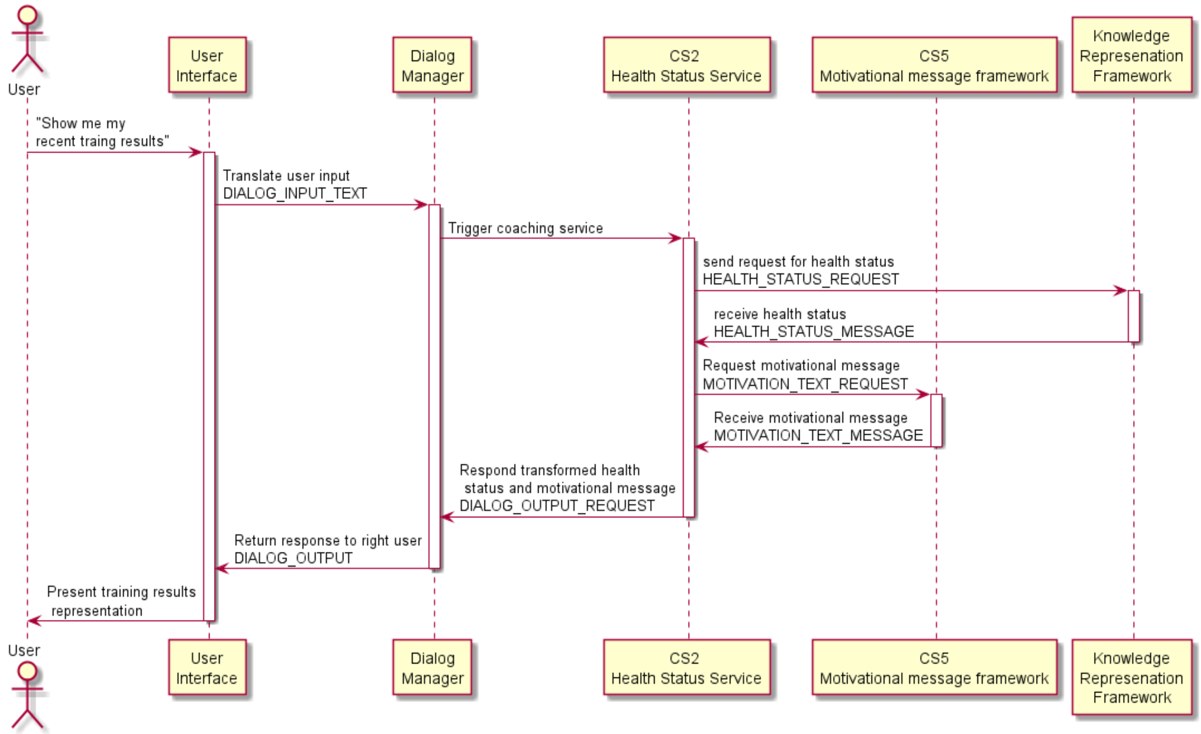

Figure 78: Data flows for test A-12 HF – CS6

Test execution:

- **Trigger**: a technician at AIT triggers the test by asking for the current health status via speech input on the tablet with “Show me my recent training results”.
  - **Integration test:** the message flow through all components was tested.
  - **Interaction test:** It is tested if the health status message sent back form the KRF is shown on the UI.

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
The input is the verbal command "Show my my recent training results" to trigger a HEALTH_STATUS_REQUEST message sent to the KRF.	The output is the health status presented on the tablet in textual form including a motivational message presented textually and verbally	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 78 were supervised by technical people by help of the log files.

Services: **CS6 Intelligent notifications/scheduler**	*Requirement:* **R5-3 Notification and reminders**
	Context: The VC detects that the user recorded low levels of motor activities in the past three days **Test:** The technician verifies that the VC sends a notification to remind and motivate the user to be more active

Test documentation:

Integration:

The test involves the avatar base UI on the tablet, die dialog manager as part of CS6, the rehabilitation coaching modules (CS5) and the reasoner (the KRF). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is a motivational message to be more active shown to the user on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 79 below.

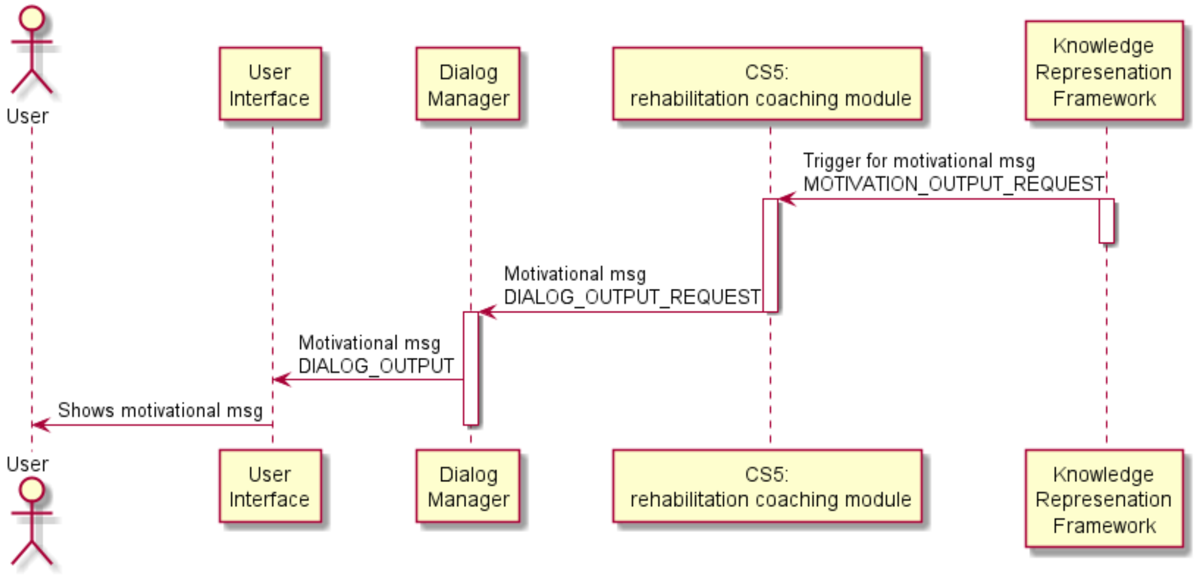

Figure 79: Data flows for test A-12 HF – CS6

Test execution:

- **Trigger:** the reminder is triggered by the KRF manually for the test.
  - **Integration test:** the message flow through all components was tested.
  - **Interaction test:** The reminder has been shown on the tablet via speech output and a textual reminder message and the user can confirm the proposal

Test validation:

- The log of the end-user UI is checked if the motivational message could be received.
- The KRF is checked if the trigger has been created correctly

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
Input is a manually triggered MOTIVATION _OUTPUT_REQUEST with the key “be_more_active”.	Based on the key, an appropriate motivational message is generated by the CS5 based on the database holding pre-defined messages structured in categories. This message is then presented on the tablet verbally and textually.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 79 were supervised by technical people by help of the log files.

Services: **CS-5 Rehabilitation coach**	*Requirement*: **R4-6 Personalized and context-aware interaction and feedback**
	Context: VC asks the user at different standardised moments during the training about his/her perceived exertion. **Test:** - The technician verifies that VC asks the perceived exertion level at the end of each exercise during the aerobic training - The user grades his exertion level - The technician verifies that the grades of the user has been correctly stored by checking the database - The technician verifies that VC records the answer and depending on the answer, it sends the user an empathic message: e.g. its's very good, you're doing better than the last time.

<u>Test documentation:</u>

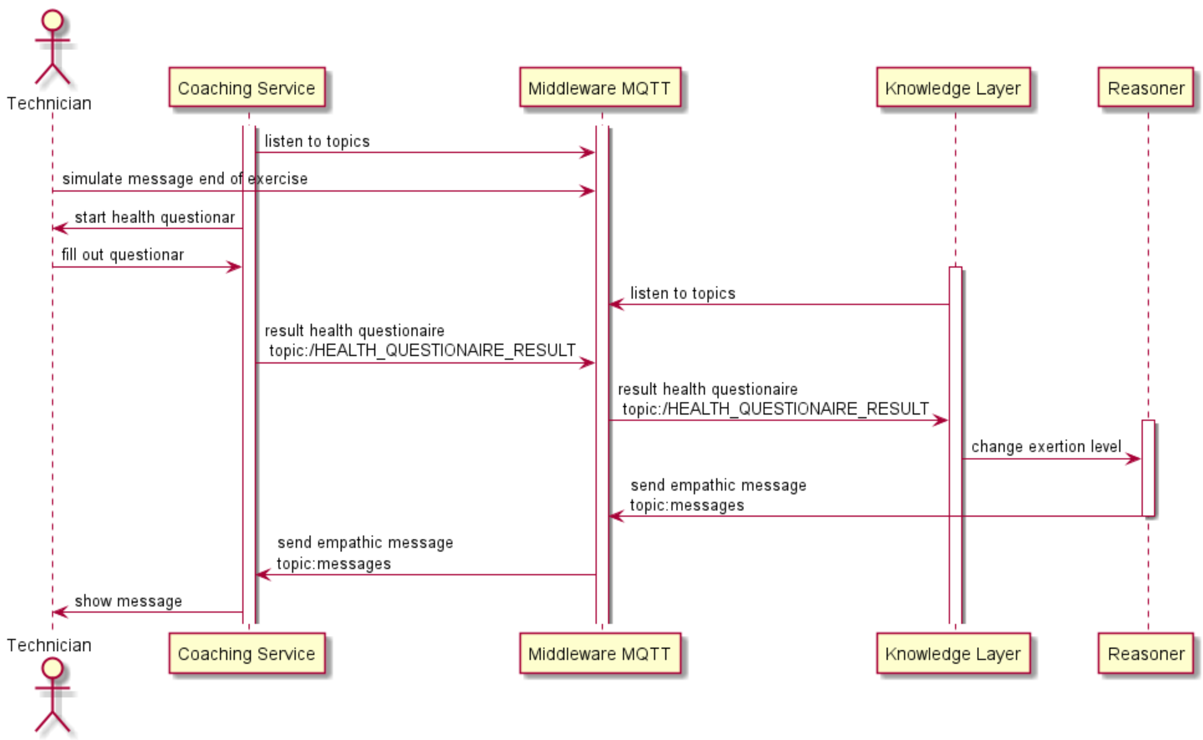

Figure 80: Data flows for test A-12 HF – CS5 - R4-6

Integration:

The interface to integrate clinical state for a patient is defined and validated. This information lay ground to the personalisation of an individual care plan. Once the knowledge layer receives updates for specific clinical attributes of a specific patient this information is stored and can be extract from our RDF-graphs in the triple store.

After processing the information stored in the reasoner according to the definition in the use case the framework then proposes a new scheduled activity to be added to the patients care plan for this day.

The result of this process is a message to the coaching service that is shown to the patient via the GUI. The positive or negative feedback depending on the grading of exertion level will be provided to the topic "vcare/< patientid >/message/service/message" in the vCare middleware as defined in D5.3.

Adjustments and Specifications during TechLab with medical partners from UMFCD:

Based on the exertion level of the patient not only should the patient receive feedback, but the activities parameters should be adjusted in the following way:

- If Borg grades: 1-2 = Increase session duration by 3 minutes
- If Borg grades: 3 = increase session duration by 2 minutes
- If Borg grades: 4 = increase session duration by 1 minute
- If Borg grades: 5 - 6 = Maintain session configuration
- If Borg grades: 7 = Decrease THR with 3%
- If Borg grades: 8 = Decrease THR with 5%

- **After session length reaches 30 minutes:**
- If Borg grades: 1 - 3 = THR increases by 3%
- If Borg grades: 4 = THR increases by 4%
- If Borg grades: 5 - 6 = Maintain session configuration
- If Borg grades: 7 = Decrease THR with 3%
- If Borg grades: 8 = Decrease THR with 5%

Test setup - precondition:

- Technical partners generate exemplary clinical state attributes of a patient’s exertion level
- Integration tests on processing the state attributes of a patient
- Integrated tests on providing feedback to the patient

Test execution:

- **Integration test:** messages holding information about Borg questionnaire results are processes via the MQTT broker and stored in the knowledge layer related to a simulated patient
- **Trigger:** receiving messages about a patient Borg assessment via MQTT broker related to a aerobic training activity. Message to the topic of "vcare/<patientid>/observation"
- **Reasoner:** automatically checks if the received Borg value is higher or lower than a defined threshold value (see **Adjustments and Specifications during TechLab with medical partners from UMFCD)**
- Generated feedback by the reasoner is automatically provided to the coaching service on the topic "vcare/< patientid >/message/service/message" that is shown on the GUI of the VC to the patient

Test validation:

- the reasoner compares the current Borg assessment of the patient received by the MQTT broker to the threshold values defined by our medical partners

Simulated BORG-Assessment	Feedback published by reasoner via VC	Medical partner validation
[2]	positive	confirmed
[5]	none	confirmed
[7]	negative	confirmed

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
VC asks the perceived exertion level at the end of each exercise during the aerobic training The user grades his exertion level	depending on the answer, it sends the user an empathic message: e.g. its's very good, you're doing better than the last time.	Based on the feedback provided not only should the patient receive feedback, but the activities parameters should be adjusted in the long run

Test summary:

In this test, the subjectively perceived master exhaustion of the patient could be recorded and correctly processed by the technical components. On the one hand, the rules defined here provide the basis for direct feedback to the patient. In addition, the correct storage of the information also forms the basis for the long-term adaptation and personalisation of the individual care plan.

Services: **DS-1 Location of the patient in the house and home activity/inactivity monitoring**	*Requirement:* **R2-1Home's room detection**
	Context: The user is on the sofa in the living room and the VC localizes the room employed by the user and activates the daily staying timer for that room. **Test:** *Already tested in SD A-6 Monitoring indoor, Services: DS-1 Location of the patient in the house and home activity/inactivity monitoring, Requirement: R2-1 Home's room detection*
	Requirement: **R2-7 Home inactivity detection**
	Context: Half an hour has passed and the VC detects that the user hasn't started his chosen training. The smart home system recognizes the user is inactive in his/her bed and activates the daily timer of physical inactivity. **Test:** *Already tested in SD A-2 Coaching for an active lifestyle, Services:* DS-1 Location of the patient in the house and home activity/inactivity monitoring, *Requirement:* R2-7 Home inactivity detection
Services: **SS2 Agenda**	*Requirement:* **R3-7 Agenda interface**
	Context*:* The user is sitting in the kitchen after having his/her morning tea. The user asks the VC to consult the agenda for physical activities in order to carry out the established activity. **Test***:* *Already tested in SD A-1 Home-based Motor Activities, Services:* SS-2 Agenda, *Requirement:* R3-7 Agenda interface
	Requirement: **R3-1 Coach main interactive application, the avatar**
	Context: The user asks to know what upcoming activities are scheduled in his agenda for today through direct interaction with the avatar. **Test:** *Already tested in SD A-1 Home-based Motor Activities, Services:* SS-2 Agenda, *Requirement:* R3-1Coach main interactive application, the avatar

7.3.3 Test case Activity A-13 HF: Aerobic physical therapy

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Physical training	CS-1	R5-8
Health status	CS-2	R5-5
Rehabilitation coach	CS-5	R3-6, R4-6
Intelligent notifications scheduler	CS-6	R2-7, R2-8, R3-1, R3-6, R5-3, R5-4
Agenda	SS-2	R3-1, R3-7

Test case

<table>
<tr><th colspan="2">Activity: AEROBIC PHYSICAL THERAPY</th></tr>
<tr><td colspan="2">
Initial setting (from D1.3): As part of the First narrative/Use Case #7 and #8 Mrs. Elena profile’s at discharge from the hospital composed by
ONTOLOGY (from D1.3/D4.2):

“Patient profile”: pathology (e.g. heart failure), clinical data depicting the clinical syndrome
“Clinical State”: Weight, height, waist and hip circumference, physical activity (calories spent), exercise capacity (Watt-max test)
“Evidence Indicators”: exercise capacity, heart rate, blood pressure, tracking of exercise
“Activity”: Supervision of aerobic physical activity
“Time Event”: Individualised sessions of at least 30 minutes

REASONER (from D1.3):

Rules to improve user’s cardiovascular fitness (Rules D1.3 pg. 68, [Use Case: UC9. Linked Measure: Number of steps])
Rules to improve user’s cardiovascular fitness (Rules D1.3 pg. 68, [Use Case: UC9. Linked Measure: Aerobic activity sessions: Fast walking/treadmill/cycling])
Rules to asses user feedback (Rules D1.3 pg. 68, [Use Case: UC9. Linked Measure: Training efficiency (to manage feedback), assessment of the time spent during phase 2 within the THR])
Rules to asses user feedback (Rules D1.3 pg. 71, [Use Case: UC9. Linked Measure: Resistance training game score (to manage Feedback)])
Rules to asses user feedback (Rules D1.3 pg. 68, [Use Case: UC9. Linked Measure: Game score (to manage game difficulty level])

TECHNOLOGY from (D7.2):

Activity tracker
Tablet
Blood pressure monitoring device
Smart-home devices
Sensor based training system (REHABILITY)

</td></tr>
<tr><td rowspan="2">Services: CS5 Rehabilitation coach</td><td>Requirement: R3-6 Information interface</td></tr>
<tr><td>
Context:
The VC notifies the user that is time to perform an aerobic physical activity based on her personalised rehabilitation plan.
Test:

The technician verifies in the logfiles that the VC reproduces a reminder due to the scheduling of aerobic exercises session
The user accepts to start the session
The technician checks the logfiles to verify that the VC launches the training session

</td></tr>
</table>

Test documentation:

Integration:

The test involves the avatar base UI on the tablet, die dialog manager, the Notification manager as part of CS6 and the reasoner (the KRF). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is a motivational message is to the confirmation of the user to start an exercise training session received by the KRF.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 81.

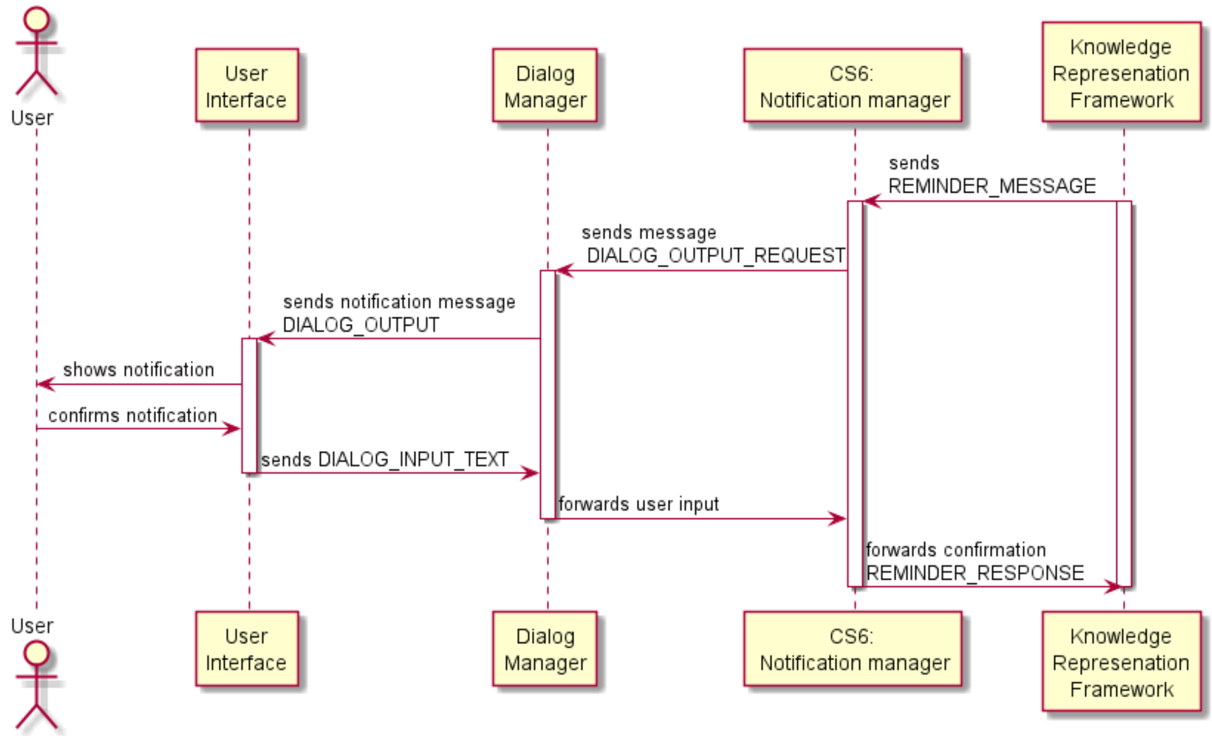

Figure 81: Data flows for test A-13 HF – CS5

Test execution:

- **Trigger:** the reminder is triggered by the KRF manually for the test.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** The reminder has been shown on the tablet via speech output and a textual reminder message

Test validation:

- The log of the end-user UI is checked if the motivational message could be received.

- The KRF is checked if the trigger has been created correctly

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
A REMINDER_MESSAGE is triggered manually within the KRF with conformation options defined.	The output is the REMINDER_RESPONSE holding the chosen response of the tester ("Yes" in this case):	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 81 were supervised by technical people by help of the log files.

<table>
<tr><td rowspan="2">Services: CS-1 Physical training</td><td>Requirement: R5-8 Physical training</td></tr>
<tr><td>Context:
The user switches on the REHABILITY and Set-Top Box and performs the recommended activity.

Test:
– The user switches on the TV and Set-Top box.
- The user performs the exercises and obtains certain results
- The technician verifies that the reached score has been stored correctly into the system</td></tr>
</table>

Adjustment: This Test Case is covered by *Services:* ***CS1 Physical Training*** *Requirement:* ***R5-8 Physical training.*** In this test documentation the games "Popping Flowers" and "Coloured Cans" are played. Besides the validation test for integrating the GAME_SESSION_STARTED message the test documentation also covers the GAME_RESULT message that is stored in the REHABILITY session and in addition is provided to the MQTT broker.

<table>
<tr><td rowspan="2">Services: CS-2 Health status</td><td>Requirements: R5-5 Health status</td></tr>
<tr><td>Context:
The VC records vital signs and physical performance of the user during training session.

Test:
- The user wears the activity tracker to monitor heart rate for 2 minutes
- The technician verifies the accuracy of data sent by the sensor</td></tr>
</table>

	- The technician verifies that at the end of the training session the VC produces a report with the exercises results and vital signs (weight, heart rate, heart rate zones, steps, exercise sessions)

Adjustment: Already testes in HF A-16 VITAL STATS CONTROL, Services: DS-5 Monitoring of vital parameters, Requirement: R7-1 Vital sings monitoring

Services: **CS-5 Rehabilitation coach**	*Requirement*: **R4-6 Personalized and context-aware interaction and feedback**
	Context: During the aerobic training the VC asks the user how she perceives exertion. **Test:** *Already tested in HF A-12 Daily Motor Activity, Services: CS5Rehabilitation coach, Requirement R4-6 Personalized and context-aware interaction and feedback*
Services: **CS-6 Intelligent notifications scheduler**	*Requirement:* **R5-3 Notifications and reminders**
	Context: The VC detects an upcoming aerobic training session and reminds the user it's time to perform his exergames also providing motivational message reminding the importance of physical activity. **Test:** - The technician verifies in the logfiles that the VC reproduces a reminder due to the scheduling of aerobic exercises session

<u>Test documentation:</u>

Integration:

The test involves the avatar base UI on the tablet, die dialog manager as part of CS6, the rehabilitation coaching modules (CS5) and the reasoner (the KRF). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is a motivational message to be more active shown to the user on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 82.

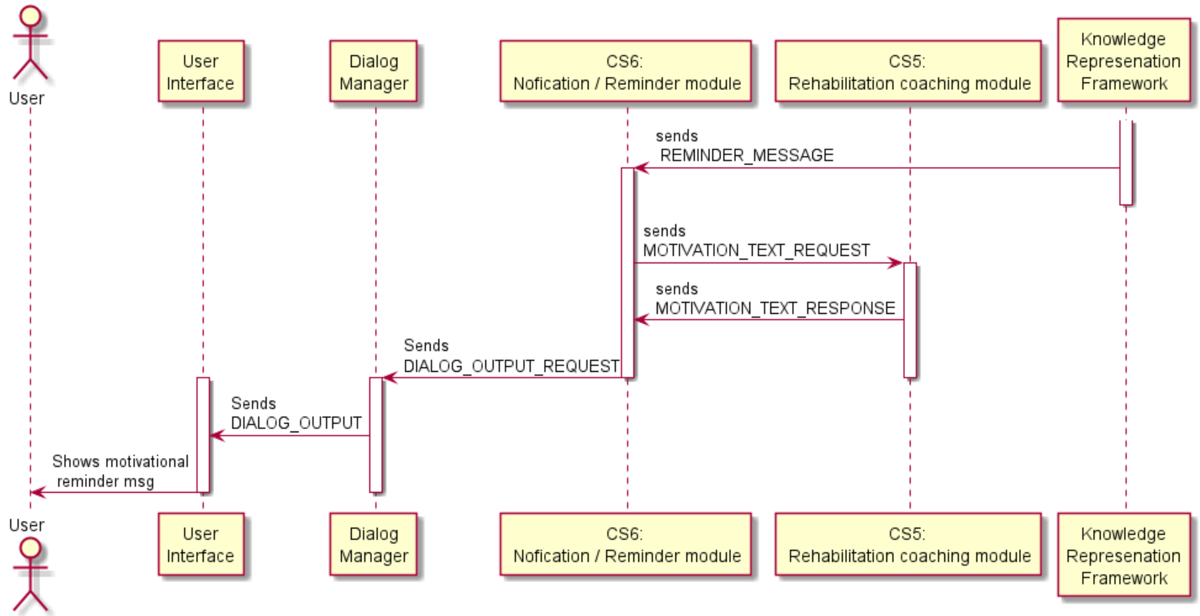

Figure 82: Data flows for test A-13 HF – CS6

Test execution:

- **Trigger:** the reminder is triggered by the KRF manually for the test.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** The reminder has been shown on the tablet via speech output and a textual reminder message

Test validation:

- The log of the end-user UI is checked if the motivational message could be received.
- The KRF is checked if the trigger has been created correctly

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
A REMINDER_MESSAGE is triggered manually within the KRF with conformation options defined and a MOTIVATION_TEXT_REQUEST key.	After adding the motivational message, the reminder is shown to the user verbally and textually.	Clinicians are satisfied; the test reflects their expectations.

Test summary:
We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 82 were supervised by technical people by help of the log files.

Services: **SS-2 Agenda**	*Requirement:* **R3-7 Agenda interface**
	Context: Before going to bed Sunday night, the user asks the VC to display all scheduled physical sessions for next week. **Test:** - Data to simulate the plan of appointments of a weekly physical session for a specific patient are inserted into the system - The user asks the VC to consult the weekly calendar - The technician verifies the reception of the information by checking the logfiles for the opening of the agenda interface

<u>Test documentation:</u>

Integration:

The test involves the avatar base UI on the tablet, die dialog manager as part of CS6, the Agenda service (SS2) and the KIOLA platform as part of the care giver UI. The KILOA platform stores the rehabilitation plans for the users and provides its information via a REST interface. The communication between all other components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is a list of activities display on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 83 below.

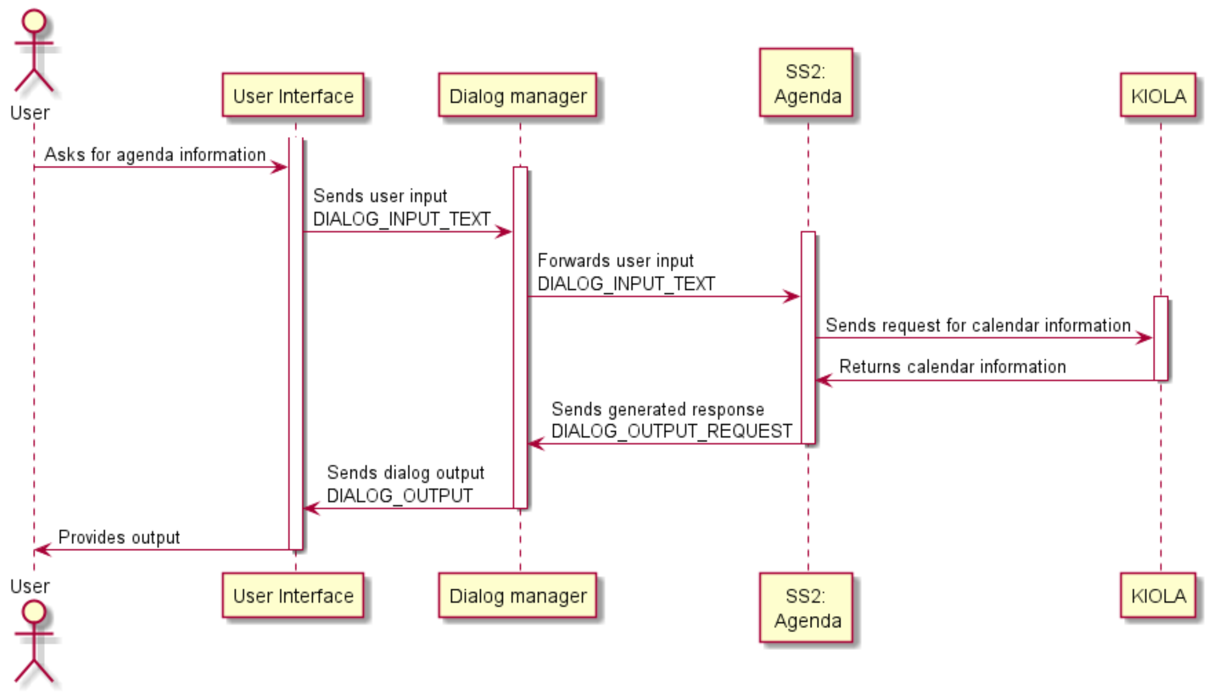

Figure 83: Data flows for test A-13 HF – SS2

Test execution:

- **Trigger:** the reminder is triggered by a technician asking the VC "Give me my activities for next week"
  - **Integration test:** the message flow through all components was tested.
  - **Interaction test:** The interaction for retrieving the weekly calendar items is tested via speech output. The results shall be shown on the display.

Test validation:

- The speech input and text output is tested by observation of the UI
- The data flows are validated by checking the logs of the Agenda service and the KIOLA platform

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
Input is the speech command "Give me my activities for next week". This is then forwarded do the agenda service to retrieve the list of activities.	The output is a list of activities to be performed in textual form.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 83 were supervised by technical people by help of the log files.

<table>
<tr><td rowspan="2">Services: CS8 User feeling</td><td>Requirement: R5-6 User feelings</td></tr>
<tr><td>Context:
VC asks questions directly to the user regarding its subjective wellbeing, scoring on a 5-point Likert scale.

Test:

Already tested in SD A-2 Coaching for an active lifestyle, Services: CS-8 User feeling, Requirement: R5-6 User feelings</td></tr>
</table>

7.3.4 Test case Activity A-14 HF: Resistance training

Services and Requirements enhancing the Activity

Service Needs (WP5)		**Functional Requirements (WP7)**
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Physical training	CS-1	R5-8
Health status	CS-2	R5-5
Rehabilitation coach	CS-5	R3-6, R4-6
Intelligent notifications scheduler	CS-6	R2-7, R2-8, R3-1, R3-6, R5-3, R5-4
User feeling	CS-8	R5-6
Body position detection	DS-2	R2-3
Agenda	SS-2	R3-1, R3-7

Test case

Activity: RESISTANCE TRAINING
Initial setting (from D1.3): As part of the First narrative/Use Case #7 and #8 Mrs. Elena profile's at discharge from the hospital composed by

<table>
<tr><td colspan="2">

ONTOLOGY (from D1.3/D4.2):

- "**Patient profile**": pathology (e.g. heart failure), clinical data depicting the clinical syndrome
- "**Clinical State**": Weight, height, waist and hip circumference, physical activity (calories spent), exercise capacity (Watt-max test)
- "**Evidence Indicators**": exercise capacity, heart rate, blood pressure, tracking of exercise
- **"Activity":** Supervision of resistance training
- **"Time Event":** Individualised sessions of at least 30 minutes

REASONER (from D1.3):

- Rules to improve user's cardiovascular fitness (Rules D1.3 pg. 68, [Use Case: UC9. Linked Measure: Number of steps])
- Rules to improve user's cardiovascular fitness (Rules D1.3 pg. 68, [*Use Case: UC9. Linked Measure: Aerobic activity sessions: Fast walking/treadmill/cycling*])
- Rules to asses user feedback (Rules D1.3 pg. 68, [*Use Case: UC9. Linked Measure: Training efficiency (to manage feedback), assessment of the time spent during phase 2 within the THR*])
- Rules to asses user feedback (Rules D1.3 pg. 71, [*Use Case: UC9. Linked Measure: Resistance training game score (to manage Feedback)*])
- Rules to asses user feedback (Rules D1.3 pg. 68, [*Use Case: UC9. Linked Measure: Game score (to manage game difficulty level)*])

TECHNOLOGY from (D7.2):

- Activity tracker
- Tablet
- Blood pressure monitoring device
- Smart-home devices
- Sensor based training system (REHABILITY)

</td></tr>
<tr><td rowspan="2">

Services: **CS-1**

Physical training

</td><td>

Requirement: **R5-8 Physical training**

</td></tr>
<tr><td>

Context:
For her 3rd session of physical activity for this week, the user has to perform a resistance training. The VC starts the suitable games for conducting resistance training and present it to the patient via the AVATAR.

Test:

- The technician verifies in the logfiles that the VC reproduces a reminder due to the scheduling of resistance training
- The user accepts to start the session and chooses verbally exergames
- The user starts the cognitive games by switching on TV and Set-Top box
- The technician checks the logfiles to verify that the VC launches the training session

</td></tr>
</table>

Test documentation:

Integration:

The test involves the avatar base UI on the tablet, the dialog manager, the CS1 involving also the REHABILITY system as part of CS1, the KRF and the reminder module (CS6). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving the game started message by the KRF.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 84 below.

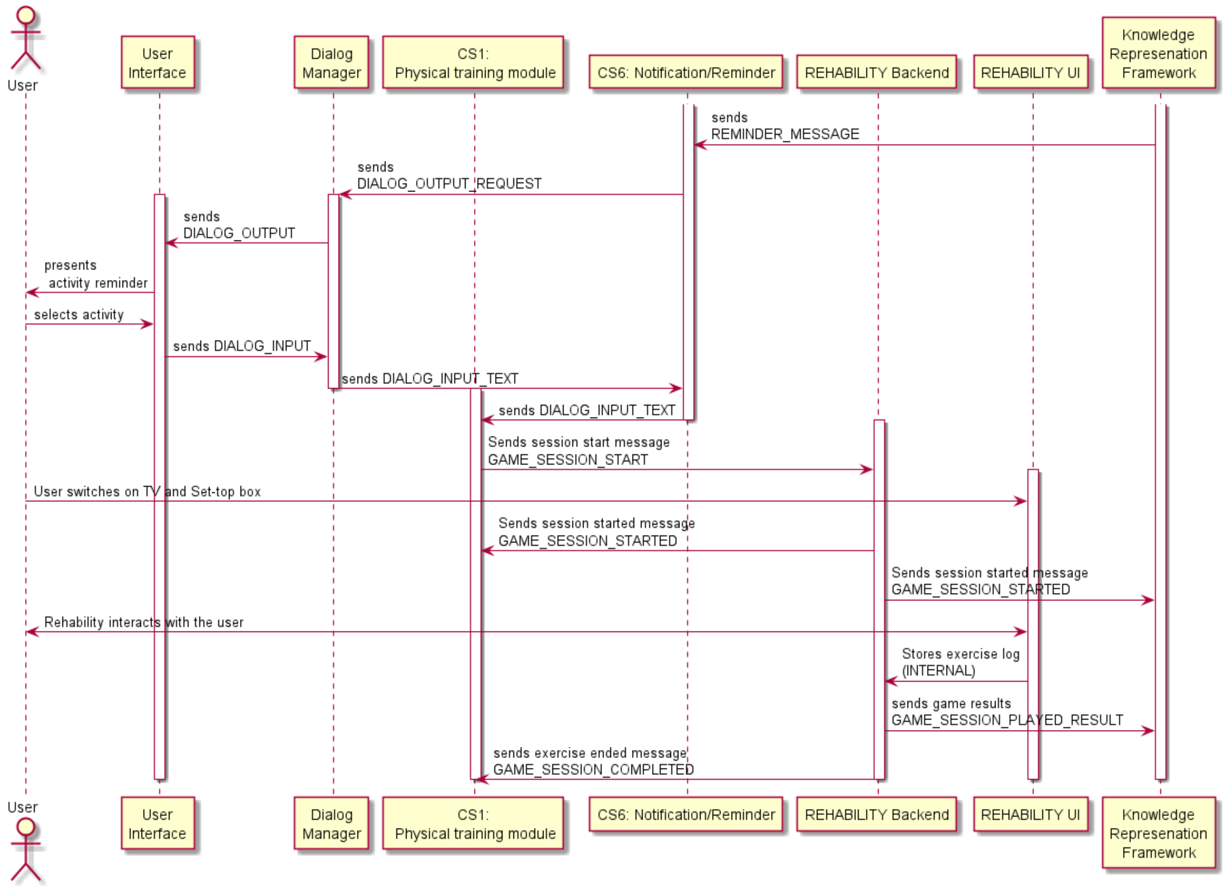

Figure 84: Data flows for test A-14 HF – CS1

Test execution:

- **Trigger**: a technician at FZI triggers the reminder message for the training by sending the related MQTT message to the KRF. Then, the user selects a proposed activity and the activity is started.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** It is tested the reminder is shown and the selected exergame is shown within the Rehability UI.

Test validation:

- The log of the modules is checked if the messages have been received
- The UIs are checked visually

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
A REMINDER_MESSAGE is triggered manually with the KRF and the reminder is shown to the user. The user selects and activity which gets started afterwards.	The output is the result of the gaming session by sending a GAME_SESSION_PLAYED_RESULT message back to the KRF	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF and IMA providing the CS1. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 84 were supervised by technical people by help of the log files.

<table>
<tr><td rowspan="2">Services: CS-2 Health status</td><td>Requirements: R5-5 Health status</td></tr>
<tr><td>Context:
During the user’s resistance training the VC monitors his vital parameters and detects a higher HR than designated

Test:
- Data simulating HR threshold are inserted into the system
- Data simulating HR overcoming the threshold are inserted into the system
- The technician verifies that IF HR overcomes the threshold, THEN the VC transmits a message to increase the pace, in order to keep the HR within the designated thresholds.</td></tr>
</table>

<u>Test documentation:</u>

Integration:

The test involves the avatar base UI on the tablet, the notification manager service (CS6), die dialog manager and the reasoner. The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of the reminder for medication intake by the end-user UI on the tablet.

Test setup - precondition:

Data simulating the heart rate of a patient are transmitted via the MQTT broker to the topic "clinical_state". Stored in the knowledge layer the system holds simulated information about a threshold value for the heart rate. Receiving new values about a patient's heart rate the reasoner compares it to the threshold value and in case triggers the notification message accordingly.

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 36.

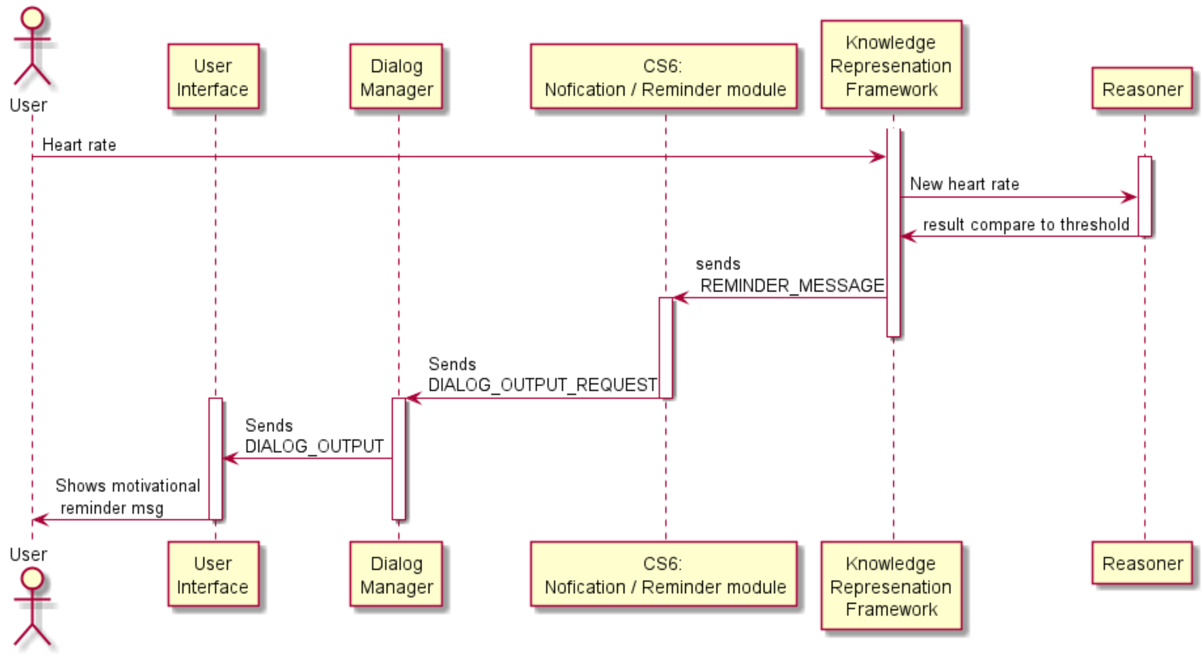

Figure 85: Data flows for test A-14 HF –CS2[17]

Test execution:

- **Trigger:** the reminder is triggered by the KRF manually for the test.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** The reminder has been shown on the tablet via speech output and a textual reminder message.

Test validation:

[17] Note: the reminder is triggered by the KRF and due to its structure it is represented by a REMINDER_MESSAGE instead of using a HEALTH_STATUS_MESSAGE for CS2

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
A REMINDER_MESSAGE is triggered manually by the KRF	The output is the content of the reminder message presented in textual and verbal form.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 85 were supervised by technical people by help of the log files

Services: **CS-5 Rehabilitation coach**	*Requirement:* **R4-6 Personalized and context-aware interaction and feedback**
	Context: During the aerobic training the VC asks the user how she perceives exertion. **Test:** *Already tested in HF A-12 Daily Motor Activity, Services: CS5Rehabilitation coach, Requirement R4-6 Personalized and context-aware interaction and feedback*
Services: **CS-6 Intelligent notifications scheduler**	*Requirement:* **R2-7Home inactivity detection**
	Context: After the first resistance training, half an hour has passed and the VC detects that the user hasn't started his/her next training. The smart home system recognizes the user is inactive in the living room and activates the daily timer of physical inactivity. **Test:** *Already tested in SD A-2 Coaching for an active lifestyle, Services:* DS-1 Location of the patient in the house and home activity/inactivity monitoring, *Requirement:* R2-7 Home inactivity detection
Services: **CS-8 User feeling**	*Requirement:* **R5-6 User feelings**
	Context: VC asks questions directly to the user regarding its subjective wellbeing, scoring on a 5-point Likert scale. **Test:** *Already tested in SD A-2 Coaching for an active lifestyle, Services:* CS-8 User feeling, *Requirement:* R5-6 User feelings

Services: DS-2 **Body position detection**	*Requirement*: **R2-3 Body position detection**
	Context: For her next resistance training the user chooses to perform exergames. The VC asks the user to step in front of her TV. **Test:** – Already tested in SD A-1 Home-based Motor Activities, Services: DS-2 Body position detection, Requirement: R2-3 Body position detection
Services: **SS-2 Agenda**	*Requirement:* **R3-1 Coach main interactive application, the avatar**
	Context: After finishing her shopping session, the user doesn't remember when is the next resistance training scheduled and asks the VC to display it. **Test:** - The user asks the VC to display her next scheduled resistance training - The technician verifies that the VC answers vocally reminding the next scheduled resistance training session

Test documentation:

Integration:

The test involves the avatar base UI on the tablet, die dialog manager as part of CS6, the Agenda service (SS2) and the KIOLA platform as part of the care giver UI. The KILOA platform stores the rehabilitation plans for the users and provides its information via a REST interface. The communication between all other components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is a list of activities display on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 86.

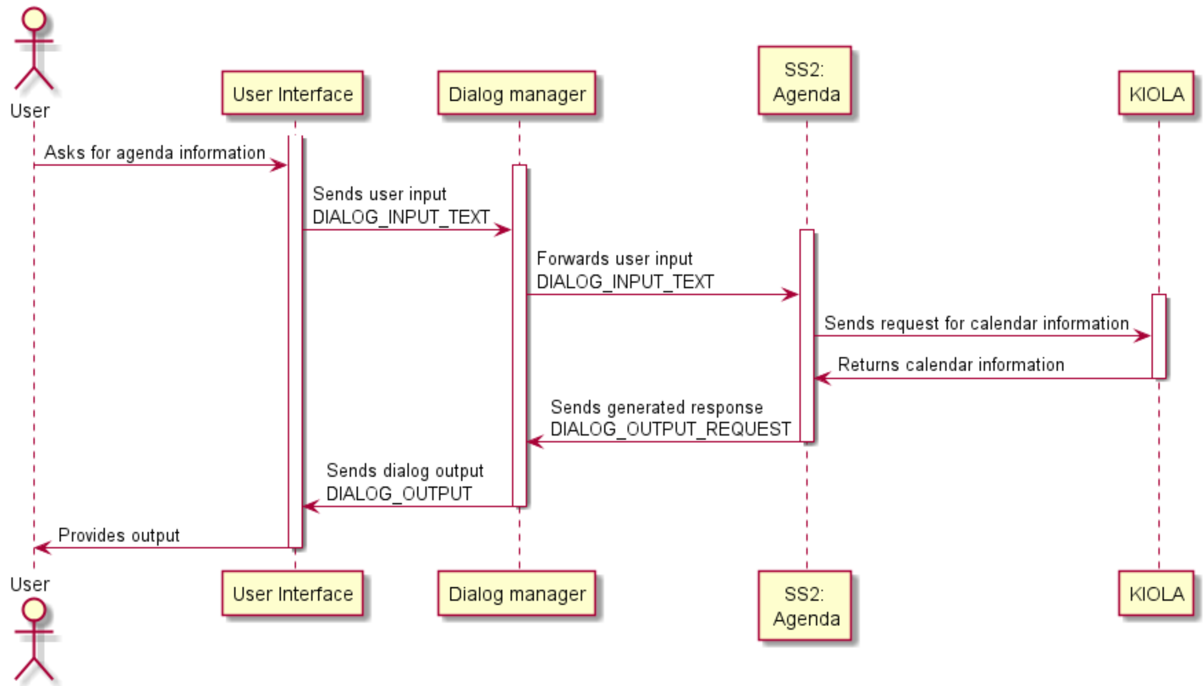

Figure 86: Data flows for test A-14 HF – SS2

Test execution:

- **Trigger:** the reminder is triggered by a technician asking the VC "When is my next resistance training?"
  - **Integration test:** the message flow through all components was tested.
  - **Interaction test:** The interaction for retrieving the relevant calendar items is tested via speech output. The results shall be shown on the display.

Test validation:

- The speech input and text output are tested by observation of the UI
- The data flows are validated by checking the logs of the Agenda service and the KIOLA platform

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
The input is a verbal command "When is my next resistance training?". This information is then requested from the KIOLA platform.	The output is a list of activities representing upcoming resistance training sessions.	

Test summary:

We validated the technical components in an integrated environment at the AIT tech lab. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 86 were supervised by technical people by help of the log files.

7.3.5 Test case Activity A-15 HF: Medication intake support

Services and Requirements enhancing the Activity.

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Monitoring of vital parameters	DS-5	R7-1, R7-2, R7-3, R7-4, R7-5, R7-6, R7-7
Intelligent notifications scheduler	CS-6	R2-7, R2-8, R3-1, R3-6, R5-3, R5-4
Agenda	SS-2	R3-1, R3-7

Test case

<table>
<tr><th colspan="2">Activity: MEDICATION INTAKE SUPPORT</th></tr>
<tr><td colspan="2">Initial setting (from D1.3): As part of the First narrative/Use Case #7,Mrs. Elena profile's at discharge from the hospital composed by

ONTOLOGY (from D1.3/D4.2):
- "Patient profile": pathology (e.g. heart failure), clinical data depicting the clinical syndrome
- "Activity": remind the patient to take the medication in order to increase medication adherence
- "Time Event": continuously monitor
- "Assessment Documents": report (document) with the output recorded daily.

REASONER (from D1.3):
- Rules to increase medication adherence. (Rules D1.3 pg. 64, [Use Case: UC7. Linked Measure: medication adherence])

TECHNOLOGY from (D7.2):
- Pillbox</td></tr>
<tr><td>Services: SS-2 Agenda</td><td>Requirement: R3-7 Agenda interface</td></tr>
<tr><td></td><td>Context:
Its Sunday night and the user decides to prepare her medication for next week in the electronic pillbox. The user asks the VC to consult the agenda of the medication established by the caregiver.</td></tr>
</table>

	Test*:* *Already tested in SD A-1 Home-based Motor Activities, Services:* SS-2 Agenda, *Requirement:* R3-7 Agenda interface

Services: **CS-6 Intelligent notifications/scheduler**	*Requirement:* **R2-8 Home behaviour monitoring**
	Context: As established by the caregiver, the user has to take pills each day at 8:00/14:00/20:00.VC detects that at 14:30 am the user hasn't taken the 14:00 am medication. The same pattern has repeated for the past 3 days. **Test:** - Data simulating usual user scheduled medication intake are inserted into the system: the user has to take pills each day at 8:00/14:00/20:00 - Pseudo data are used to simulate the current day time: 14.30am - The user does not take the pill from the pillbox - The technician verifies the accuracy of data sent by the pillbox via Bluetooth - The technician checks the database to verify that the system stores the information that "the user has not taken the pills" - The technician checks the logfiles to verify that IF 14.30 AND IF the user has not taken the pills, THEN the VC sends the user a message to remind her to take the medication as established by the doctor

Adjustment: this test is a duplication of PD A-15 Medication intake support, Services: CS6 Intelligent notifications/scheduler, Requirement: R2-7 Home inactivity detection

Services: **SS-2 Agenda**	*Requirement:* **R3-1 Coach main interactive application, the avatar**
	Context: It's 20:30 and the user has missed her pill intake again. The VC sounds a reminder. User snoozes the alarm twice for the next hour. **Test:** - Pseudo data are used to simulate the current day time: 20.30am - The user doesn't take the medication from the pillbox - The technician checks the accuracy of data sent via Bluetooth from the pillbox - The technician verifies that the information "the user has not taken the pillbox" has been stored by checking the database entries - The technician checks the logfiles to verify that, the VC activates a sound alarm - The user ignores the sound alarm - The technician verifies that after 5 minutes the first remainder, the VC activates another sound alarm inviting the user to take the medication

	- The technician verifies that the VC keeps track of user's reactions to notifications and adjusts snooze intervals e.g. less than 5 minutes in case of no adherent patient

Adjustment: due to the decision discarding the use of a pillbox (see 0) and replacing it by a reminder, the test doesn't make sense and is skipped. The medication reminder is already tested in test case A-15 PD – CS6 for R3-6. Hence, this test can be skipped.

Services: **CS-6 Intelligent notifications/scheduler**	*Requirement:* **R2-7 Home inactivity detection**
	Context: As established by the caregiver, the user has to take pills each day at 8:00/14:00/20:00.VC detects that at 14:30 am the user hasn't taken the 14:00 am medication. **Test:** *Already tested in PD A-15 Medication intake support, Services: CS6 Intelligent notifications/scheduler, Requirement: R2-7 Home inactivity detection*
Services: **CS-6 Intelligent notifications/scheduler**	*Requirement:* **R5-3 Notification and reminders**
	Context: It's 20:30 and the user has missed her pill intake twice today. **Test:** - At the scheduled time, the user does not take the medication again - The technician verifies that IF the user misses to take the medication twice in a day, THEN the VC automatically transmits a message to closest family member/caregivers to ask for support during the process

Adjustments: Informing family members/caregivers actively and outside for the vCare system (notifications within vCare using the caregiver UI is foreseen) is a new requirement and not yet reflected in previous deliverables. This new feature will be integrated in CS6 notification/reminder for the family member / non-professional case and the notification channels have to be specified (SMS, e-mail, messenger).

<u>Test documentation:</u>

Integration:

The test involves the notification / reminder module (CS6) and the reasoner (the KRF). The communication between the components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is a message to inform family members about the non-compliant medication intake of the patient.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 85 below.

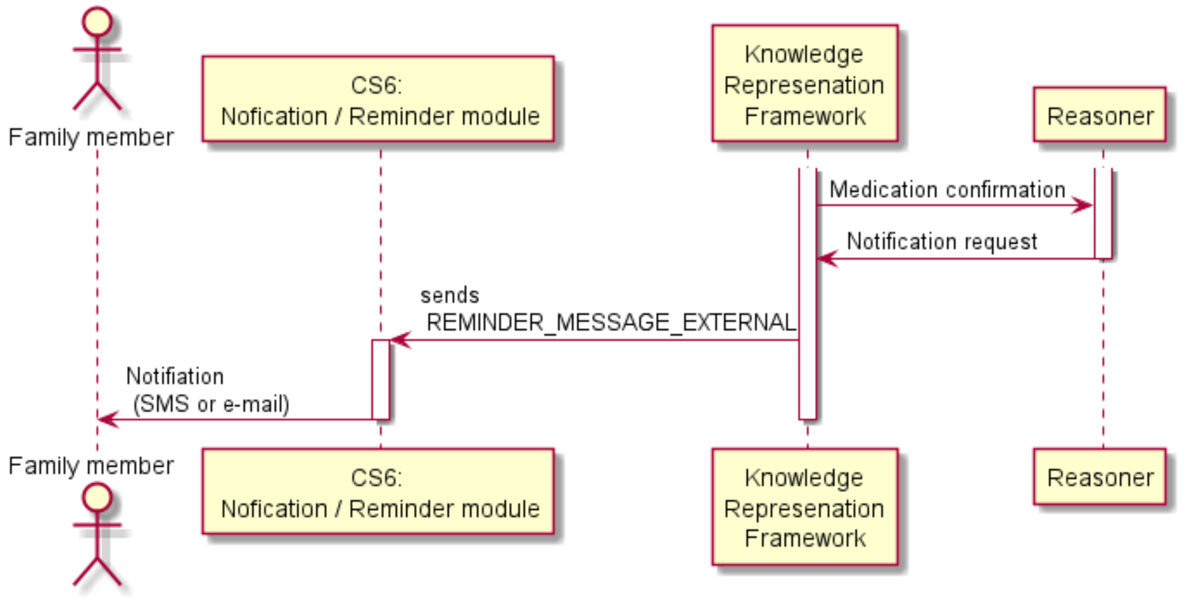

Figure 87: Data flows for test A-15 HF –CS6

Test execution:

- **Trigger:** the reminder is triggered by the KRF manually for the test to be send to the reasoner.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** The reminder has been triggered to be sent to family member which is defined in the patient's profile (simulated for the test case).

Test validation:

- The log of CS6 is checked if the notification message is generated.
- The KRF is checked if the trigger has been created correctly

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
the knowledge layer stores information about scheduled medication intake. At the given	A notification message is generated at CS6 to be sent vie SMS and/or email.	Clinicians are satisfied; the test reflects their expectations.

time the reasoner triggers the reminder

Test summary:

We validated the technical components in an integrated environment at the AIT tech lab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 85 were supervised by technical people by help of the log files.

Services: **CS-6 Intelligent notifications/scheduler**	*Requirement:* **R3-6 Information interface**
	Context: The user has taken the medication as recommended using the pillbox. **Test:** - At the scheduled time the user takes the medication from the pillbox - The technician verifies that the system receives the data from the pillbox by checking the database entries - The technician checks the logfiles to verify that IF the user takes the medication at the scheduled time, THEN the VC detects increased adherence and sends a positive message to the user informing that the medication is taken correctly as scheduled

Adjustment: due to the decision discarding the use of a pillbox (see 32) and replacing it by a reminder, the test doesn't make sense and is skipped. The medication reminder is already tested in test case A-15 PD – CS6 for R3-6. Hence, this test can be skipped.

7.3.6 Test case Activity A-16 HF: Vital stats control

Services and Requirements enhancing the Activity.

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Monitoring of vital parameters	DS-5	R7-1, R7-2, R7-3, R7-4, R7-5, R7-6, R7-7

Test case

<table>
<tr><td colspan="2" align="center">Activity: VITAL STATS CONTROL</td></tr>
<tr><td colspan="2">Initial setting (from D1.3): As part of the First narrative/Use Case #7 and #8 Mrs. Elena profile's at discharge from the hospital composed by

ONTOLOGY (from D1.3/D4.2):
- "Patient profile": pathology (e.g. heart failure), clinical data depicting the clinical syndrome
- "Evidence Indicators": exercise capacity, heart rate, blood pressure, tracking of exercise
- "Activity": Supervision of vital stats
- "Time Event": permanently

REASONER (from D1.3):
- Rules to improve user's cardiovascular fitness (Rules D1.3 pg. 68, [Use Case: UC9. Linked Measure: Aerobic activity sessions: Fast walking/treadmill/cycling]

TECHNOLOGY from (D7.2):
- Activity tracker
- Blood pressure monitoring device</td></tr>
<tr><td>Services: DS-5 Monitoring of vital parameters</td><td>Requirement: R7-1 Vital sings monitoring</td></tr>
<tr><td></td><td>Context:
The user wears the activity tracker throughout the day doing his/her regular activities.

Test:
- The user wears the activity tracker
- The technician checks the correct reception of data by the system by checking the database entries</td></tr>
</table>

Test documentation

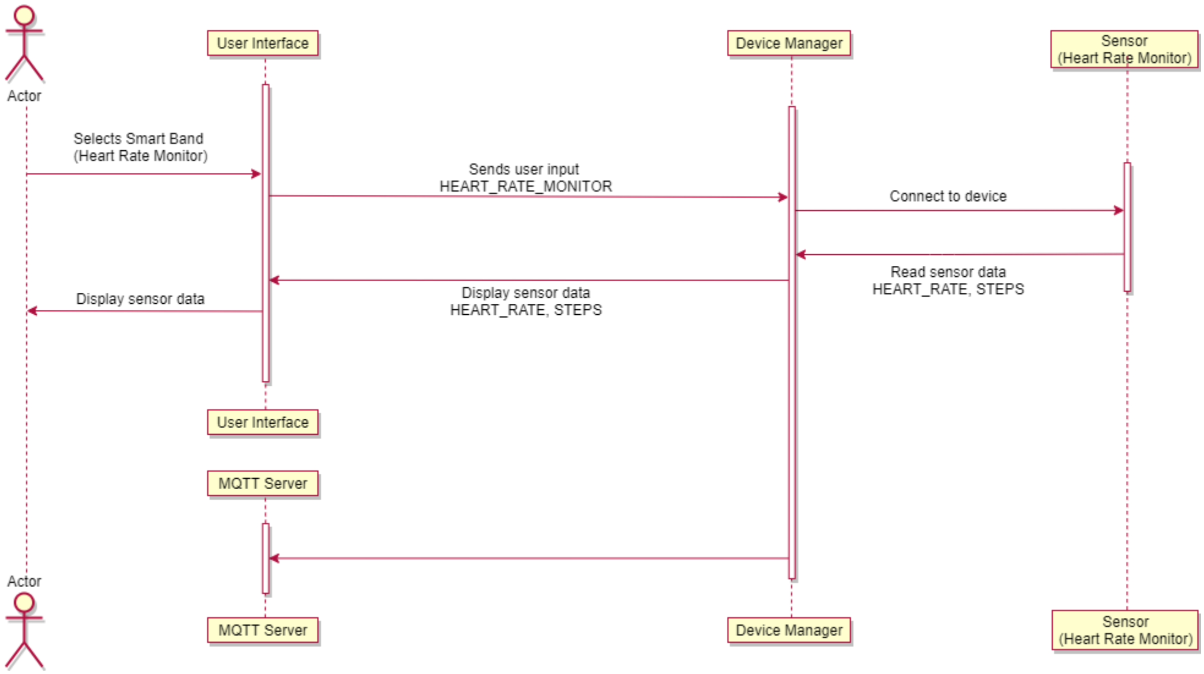

Figure 88: Data flows for test A-16 HF –DS-5 - R7-1

Integration:

Once the patient puts on the activity tracker the measurements are taken and sent automatically.

The results of the measurements performed in this test are displayed to the patient via the GUI and sent to the MQTT server in JSON form to the topics "vcare/<patientId>/observation/heart_rate" and "vcare/<patientId>/observation/number_of_steps" respectively to be processed by the technical partners.

Test setup - precondition:

- The user has to wear the activity tracker throughout the day

Test execution:

- The user wears the activity tracker throughout the day doing his/her regular activities
- The relevant values (heart rate, number of steps) are stored and sent via JSON to MQTT, to the topics of "vcare/<patientId>/observation/heart_rate" and "vcare/<patientId>/observation/number_of_steps" respectively.
- These values are sent once every few minutes (the rate is predefined).

Test validation:

- The technician checks the correct reception of data by the system by checking the database entries

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
The input is generated by the activity tracker of the patient and consists of heart rate and number of steps measurements.	The output consists of the messages HEART_RATE and STEPS received in MQTT	Clinicians are satisfied; the test reflects their expectations.

Test summary:

This test focuses on continuous recording of the patient's heart rate and number of steps during regular activities in order to observe his/her daily activity and monitor the heart rate during high effort activities.

<table>
<tr><td rowspan="2">Services: DS-5 Monitoring of vital parameters</td><td>Requirement: R7-2 Activity tracker, outdoors and indoors physical activity monitoring</td></tr>
<tr><td>Context:
The user wears the activity tracker during physical training. VC evaluates her results and compares them with the rehabilitation goal. The compliance is increased.

Test:
- Data simulating the rehabilitation goals are inserted into the system
- The user performs physical activity wearing the activity tracker
- The technician verifies that the VC records heart rate, number of steps, calories burned data from activity tracker
- The technician verifies that, at the end of the activity, the VC sends a report with results
- The technician verifies that IF results are compliant with the rehabilitation goals, THEN VC increases the challenge of the next training session</td></tr>
</table>

Test documentation

Integration: This test proves the integration between the DS5 (monitoring of vital parameters), the CS-1 (Physical Training) and the Knowledge Representation Framework.

The DS5 is in charge of retrieving data from sensors and made it available to the rest of services through MQTT topics. In this case DS5 is connects to the activity tracker when the session is about to start and subscribes to HR and step count data. The CS1 receives this data through a MQTT subscription and records the time series for both parameters. When session finishes, the CS1 sends a message to the vcare/<<patientId>>/activity/<<actId>>/finished topic.

The KRF receives the message and assesses the activity goal against the received result (150 steps done vs 100 steps foreseen) and decided to increase the difficulty for future activities to 150 steps. This adaptation is published to the *vcare/<<patientId>>/careplan/modified* topic.
The overall flow is presented in the following diagram (MQTT broker omitted for simplicity):

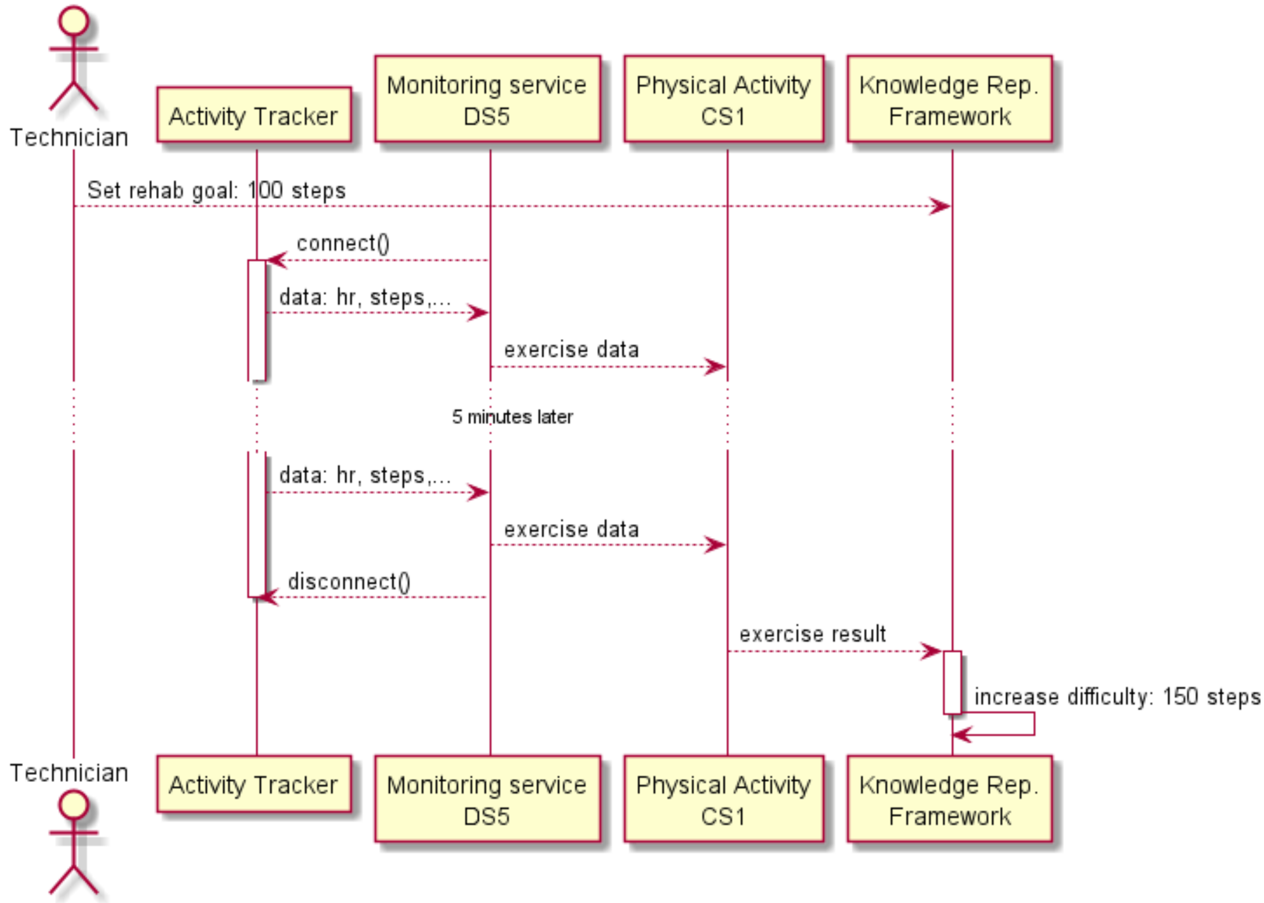

Figure 89: Data flows for test A-16 HF – DS5 – R7-2

Test setup - precondition:

- The test assumes the patient has a careplan assigned and that the careplan contains a physical training activity with a goal of 100 steps.
- The test assumes the patient has an activity tracker device assigned and linked to the DS5 service.

Test execution:

Physical activity is triggered manually by the technician sending the *vcare/<<patientId>>/activity/<<actId>>/started* event. The CS1 service monitors activity for 5 minutes and finishes the session sending the results through the *vcare/<<patientId>>/activity/<<actId>>/finished* topic with contents:

```
{
   "topic": "vcare/56e39ac5-5ada-4e43-ba35-af4d6eacd188/activity/testactivity/finished",
   "properties": {
      "USER_ID": "56e39ac5-5ada-4e43-ba35-af4d6eacd188",
```

```
        "INTERACTION_ID": "f54fbde4-73f6-4d3f-8b57-fc5785e402f3",
        "TIMESTAMP": 1593505738,
        "GAME_ID": 4,
        "CONTENT": {
          "@context":{
            "vcs": "http://ontology.vcare-project.eu/vcare_ontology_schema.ttl#"
          },
          "vcs:sheduledActivity":{
            "id":"testactivity",
            "vcs:startTime":"2020-07-13T10:43:55Z",
            "vcs:endTime":"2020-07-13T10:48:55Z",
            "vcs:goal":{
              "owl:hasValue": 100,
              "rdf:type":"vcs:step_count",
            },
            "vcs:result": {
              "vcs:heartRate": 123,
              "vcs:step_count:":150
            }
          },
          "
        }
    }
}
```


The knowledge representation framework assesses the received value and, based on the rules defined, decides to update the next scheduled activity with a higher goal. This is done publishing an update of the careplan:


```
{
    "topic": "vcare/56e39ac5-5ada-4e43-ba35-af4d6eacd188/careplan/modified",
    "properties": {
        "USER_ID": "56e39ac5-5ada-4e43-ba35-af4d6eacd188",
        "INTERACTION_ID": "155fbde4-33f6-4d5f-8b57-6c5785e502f3",
        "TIMESTAMP": 1593506783,
        "GAME_ID": 4,
        "CONTENT": {
          "@context":{
            "vcs": "http://ontology.vcare-project.eu/vcare_ontology_schema.ttl#"
          },
          "vcs:scheduledActivity":{
            "id":"testactivity2",
            "vcs:goal":{
              "owl:hasValue": 150,
              "rdf:type":"vcs:step_count",
            },
          },
```

```
        "
      }
    }
}
```

Test validation:
The different interactions have been correctly triggered, and the messages exchanged through the MQTT broker.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
An activity with a goal in step count is fed into the system	The CS5 detects that physical activity is available and starts the communication to the tracker device. The results are sent to the MQTT broker and intercepted by the KRF, which runs an assessment to compute the goal for the next activity scheduled	Clinicians are satisfied; the test reflects their expectations.

Test summary: We validated that the data gathered from the activity tracker can be used to monitor a physical activity and, later, used to adapt the difficulty of s scheduled activities.

<table>
<tr><td rowspan="2">Services: DS-5 Monitoring of vital parameters</td><td>Requirement: R7-3 Blood pressure monitoring</td></tr>
<tr><td>Context:
The VC reminds the user it's time to measure her blood pressure. User agrees.

Test:
- The technician verifies that at the scheduled time the VC sends a notification for the user to measure blood pressure
- The user agrees
- The technician verifies the storage of the positive answer into the system
- The user uses the blood pressure monitoring device
- The technician verifies the accuracy of data sent via Bluetooth by the sensor
- The technician verifies that the blood pressure measured corresponds to the value stored in the database</td></tr>
</table>

<u>**Test documentation**</u>

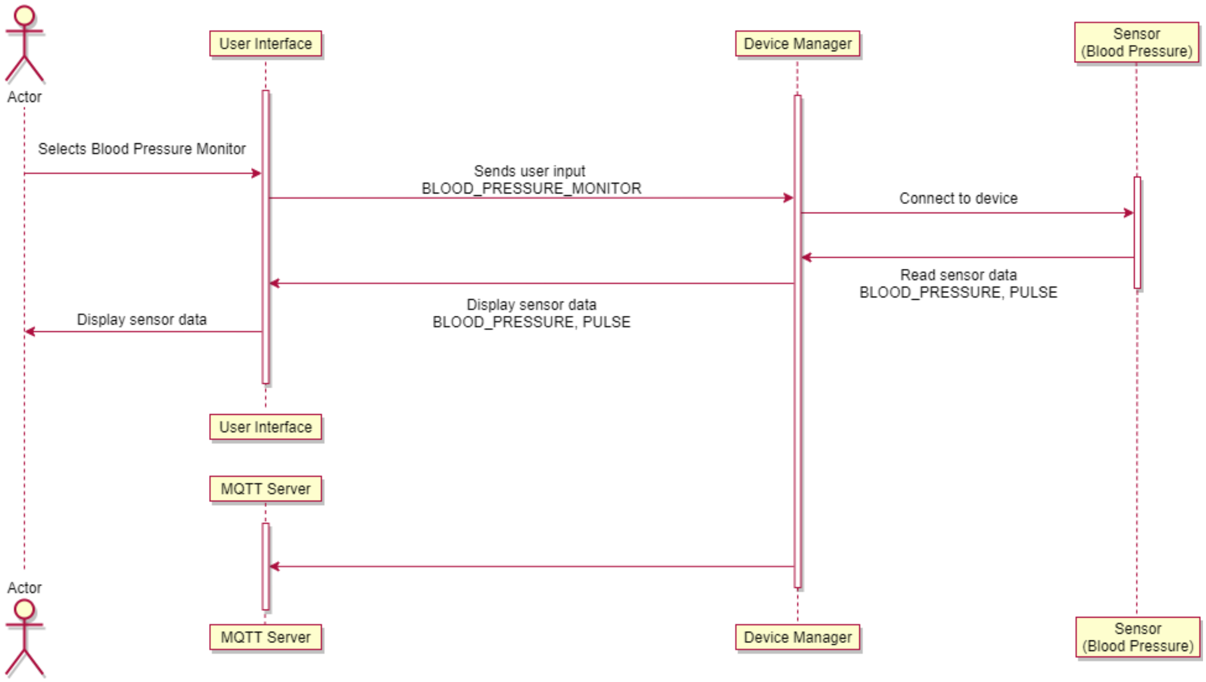

Figure 90: Data flows for test A-16 HF – DS5 – R7-3

Integration:

Once the patient receives the reminder from the VC regarding the blood pressure measurement, he/she proceeds in performing the measurement.

The results of the measurements performed in this test are displayed to the patient via the GUI and sent to the MQTT server in JSON form to the topic "vcare/<patientId>/observation/blood_pressure" to be processed by the technical partners.

Test setup - precondition:

- The VC reminds the user it's time to measure his/her blood pressure

Test execution:

- The user selects the blood pressure monitor from the list of available devices
- The user initiates the measurement using the selected device
- The relevant values (blood pressure, pulse) are stored and sent via JSON to MQTT, to the topic "vcare/<patientId>/observation/blood_pressure"
- Trigger: the VC notifies the user to measure his/her blood pressure

Test validation:

- The reasoner compares the current state of the patient received by the MQTT broker to the values of the previous measurements

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
The input is generated by the blood pressure device measuring the patient's blood pressure and pulse.	The output consists of the messages BLOOD_PRESSURE and PULSE received in MQTT	Clinicians are satisfied; the test reflects their expectations.

Test summary:

This test focuses on recording the patient's evolution regarding his/her blood pressure and on processing the data in order to tailor personalized training sessions and advice.

7.3.7 Test case Activity A-17 HF: Weight control

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Health status	CS-2	R5-5
E-Learning	CS-4	R5-2
Agenda	SS-2	R3-1, R3-7
Standby	SS-3	R3-11

Test case

Activity: WEIGHT CONTROL
Initial setting (from D1.3): As part of the First narrative/Use Case #7 and #8 Mrs. Elena profile's at discharge from the hospital composed by **ONTOLOGY** (from D1.3/D4.2): - **Patient profile**": pathology (e.g. heart failure), clinical data depicting the clinical syndrome - "**Clinical State**": NYHA Class II heart failure, obese - "**Evidence Indicators**": weight, waist circumference - **"Activity":** Weight monitoring - **"Time Event":** at least twice a week

REASONER (from D1.3): - Rules to improve user's weight (Rules D1.3 pg. 65, [Use Case: UC8. Linked Measure: Weight monitoring]) **TECHNOLOGY** from (D7.2): - Scale

Services: ***CS*-2 Health status**	*Requirements:* **R5-5 Health status**
	Context: The VC detects the user has gained 500g over 2 consecutive measurements the past week. **Test:** - Data simulating the increase of weight of the user are inserted into the system - The technician verifies that IF the user's weight is increased, THEN the VC notifies the user to measure her weight more frequently and updates users "risk management profile"

Test documentation

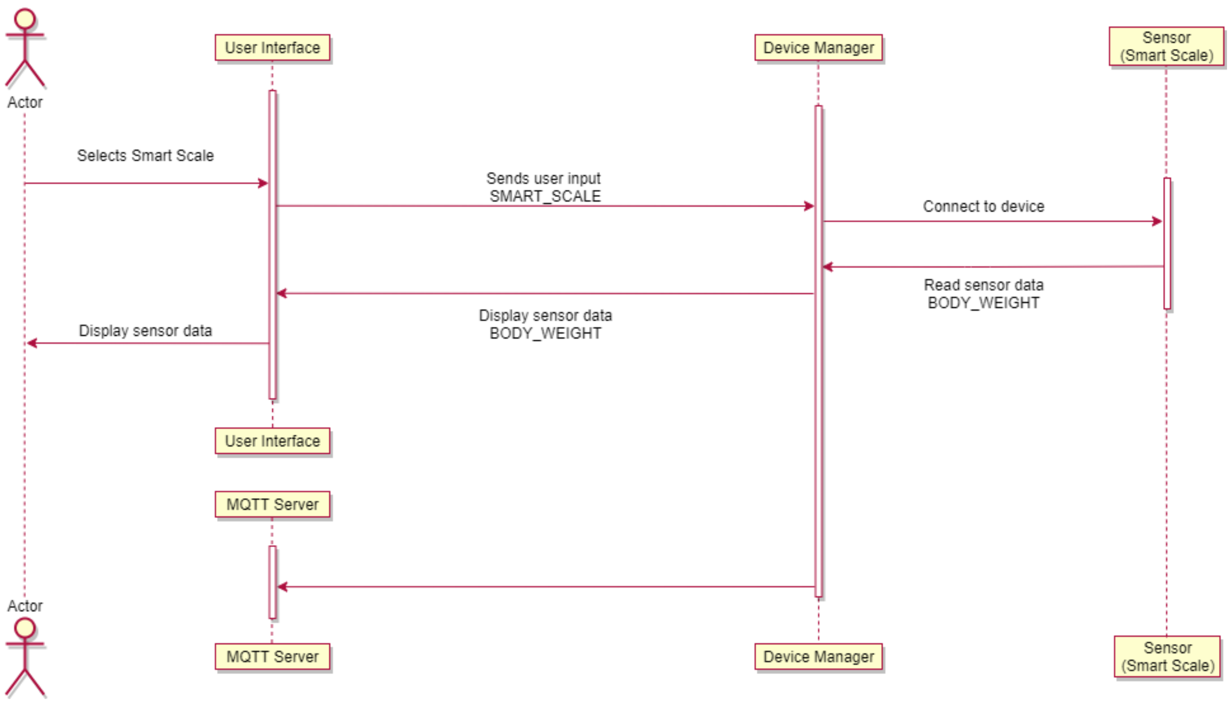

Figure 91: Data flows for test A-17 HF – CS-2 – R5-5

Integration:

Once the patient receives the notification from the VC regarding the weight change,d he/she performs the required weight measurement.

The results of the measurements performed in this test are displayed to the patient via the GUI and sent to the MQTT server in JSON form to the topic "vcare/<patientId>/observation/body_weight" to be processed by the technical partners.

Test setup - precondition:

- The VC notifies the user about his/her weight gain based on previous measurements and asks for another weight measurement

Test execution:

- The user selects the smart scale from the list of available devices
- The user initiates the measurement using the selected device
- The relevant values (body weight) are stored and sent via JSON to MQTT, to the topic "vcare/<patientId>/observation/body_weight"
- Trigger: the VC notifies the user to measure his/her weight

Test validation:

- The reasoner compares the current state of the patient received by the MQTT broker to the values of the previous measurements

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
The input is generated by the scale weight when the patient steps on it and it is the measurement of the patient's body weight.	The output is the message BODY_WEIGHT received in MQTT	Clinicians are satisfied; the test reflects their expectations.

Test summary:

This test focuses on recording the patient's evolution regarding his/her weight and on processing the weight data in order to tailor personalized training sessions and advice.

Services: **CS-4 E-Learning**	*Requirement*: **R5-2 E-learning**
	Context:

	The VC starts the suitable e-learning educational and informative contents for weight control. **Test:** - The technician verifies that IF the user's weight is increased, THEN the VC asks the user if he wants to participate in a virtual lesson on "weight control" - The user agrees - The technician checks the logfile to verify that IF positive answer, THEN the Virtual Coach opens e-learning service and launches the lesson

Test documentation:

Integration:

The test involves the avatar base UI on the tablet, the dialog manager, the KRF, and the e-learning service (CS4). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving the e-learning content by the user on the UI running on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 92 below.

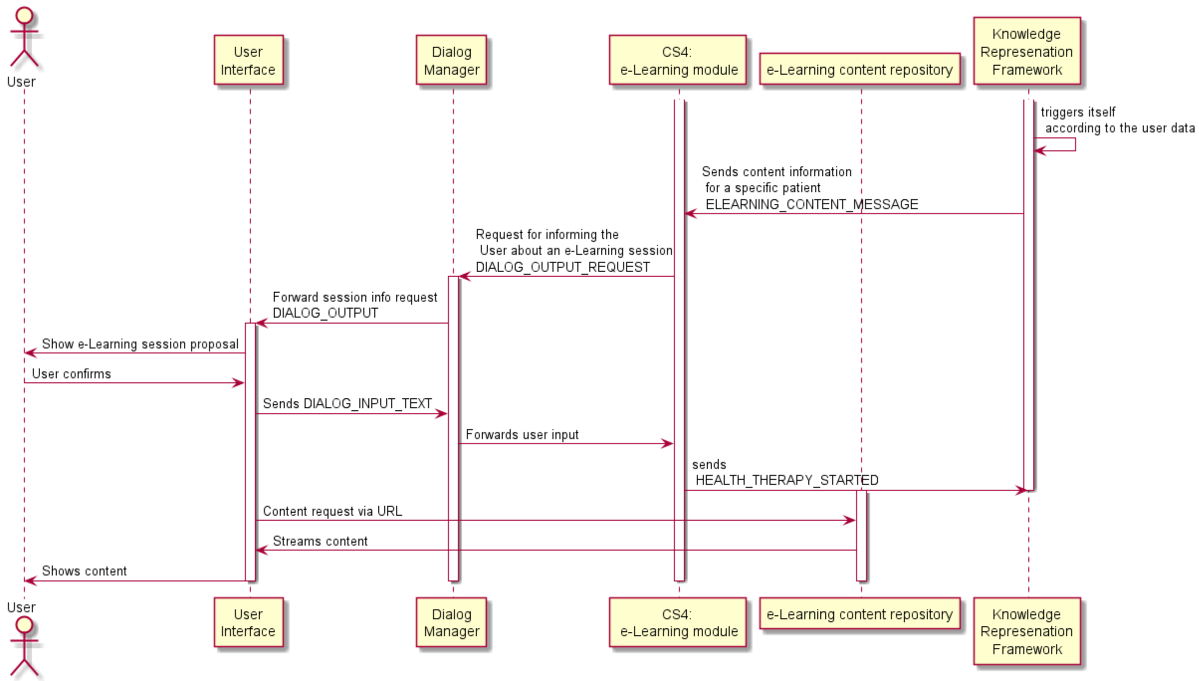

Figure 92: Data flows for test A-17 HF – CS4

Test execution:

- **Trigger**: a technician at FZI triggers the test by setting the appropriate thresholds needed to invoke the e-learning message by the reasoner.
  - **Integration test:** the message flow through all components was tested.
  - **Interaction test:** It is tested if the e-learning session is established on the UI.

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
An ELEARNING_CONTENT_MESSAGE is triggered by the KRF, leading to a DIALOG_OUTPUT_REQUEST message by CS4 to inform the user.	After confirmation the e-learning session is started and this is sent back to the KRF by a HEALTH_THERAPY_STARTED message.	Clinicians are satisfied; the test reflects their expectations.

Test summary:
We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 92 were supervised by technical people by help of the log files.

<table>
<tr><td rowspan="2">Services: SS-2 Agenda</td><td>Requirement: R3-1 Coach main interactive application, the avatar</td></tr>
<tr><td>Context:
At the first interaction of the user with the VC he/she is asked to choose two days per week for weight monitoring.

Test:
- The VC asks user to choose weight monitoring days e.g. Monday and Thursday
- The user chooses the days
- The technician checks the database to verify that the user’s answers has been correctly stored</td></tr>
</table>

Test documentation:

Integration:

The test involves the avatar base UI on the tablet, the notification manager service (CS6), die dialog manager and the reasoner (the KRF). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of the message response from the user at the KRF.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 93.

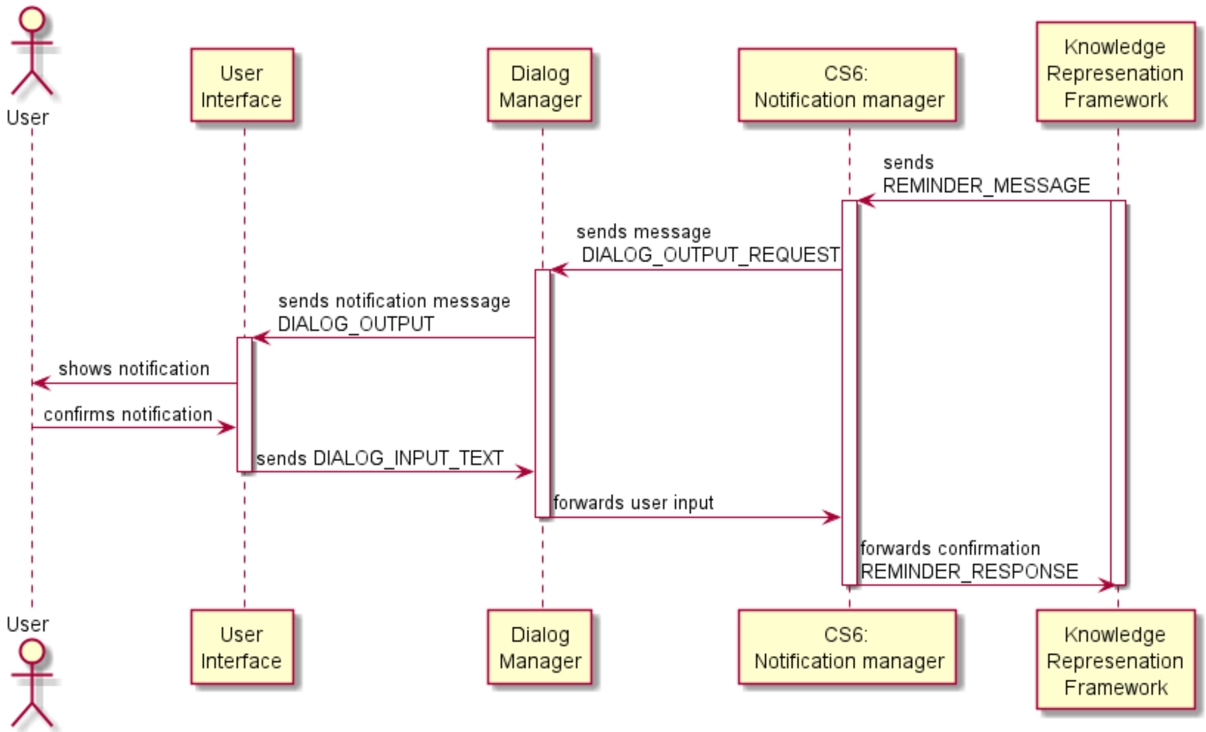

Figure 93: Data flows for test A-17 HF – SS2

Test execution:

- **Trigger:** the reminder is triggered by the KRF manually for the test.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** The massage has been shown on the tablet via speech output and a textual reminder message and the user can choose among the options provided.

Test validation:

- The log of the end-user UI is checked if the response could be received.
- The KRF is checked if the response has been received

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
A REMINDER_MESSAGE with confirmation options is generated manually by the KRF	The output is the REMINDER_RESPONSE sent back to the KRF.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 54 were supervised by technical people by help of the log files.

Services: **SS-2 Agenda**	*Requirement:* **R3-7 Agenda interface**
	Context: User asks the VC to check the agenda for next scheduled weight measurement. **Test:** *Already tested in SD A-1 Home-based Motor Activities, Services:* SS-2 Agenda, *Requirement:* R3-7 Agenda interface

Services: **SS-3 Standby**	*Requirement:* **R3-11 Standby mode**
	Context: The user goes to the seaside for spring holiday and is unable to monitor her weight for that period of time. The user sets then the standby mode. **Test:** *Already tested in HF A-3 E-learning, Services:* SS-3 Standby, *Requirement:* R3-11 Standby mode

7.3.8 Test case Activity A-18 HF: Smoking cessation activity

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Physical training	CS-1	R5-8
User feeling	CS-8	R5-6
E-Learning	CS-4	R5-2
Agenda	SS-2	R3-1, R3-7

Test case

Activity: SMOKING CESSATION ACTIVITY	
Initial setting (from D1.3): As part of the First narrative/Use Case #10, Mr. Gheorghe profile's at discharge from the hospital composed by **ONTOLOGY** (from D1.3/D4.2): - "**Patient profile**": pathology (e.g. heart failure), clinical data depicting the clinical syndrome - "**Evidence Indicators**": exercise capacity, heart rate, blood pressure, tracking of exercise - **"Activity":** Progressive decrease of smoked cigarettes - **"Time Event":** Individualised sessions of at least 5 minutes **REASONER** (from D1.3): - Rules for increase patient's knowledge to improve behaviour/reduce risks (Rules D1.3 pg. 72, [*Use Case: UC10 and 6 Linked Measure: progressive decrease of smoked cigarettes])* **TECHNOLOGY** from (D7.2): - Tablet	
Services: **SS2 Agenda**	*Requirement:* **R3-7 Agenda interface**
	Context*:* The user asks the VC to consult the agenda in order to carry out the established activity. **Test:** *Already tested in SD A-1 Home-based Motor Activities, Services:* SS-2Agenda*, Requirement:* R3-7Agenda interface
Services: **CS8 User feeling**	*Requirement:* **R5-6 User feelings**
	Context: VC asks questions to the user regarding its subjective wellbeing, scoring with a 5-points Liker scale. **Test:** *Already tested in SD A-2 Coaching for an active lifestyle, Services:* CS-8 User feeling*, Requirement:* R5-6 User feelings
Services: **CS-4 E-Learning**	*Requirement*: **R5-2 E-learning**
	Context: The Virtual Coach asks the user if he wants to participate in a virtual lesson on smoking cessation. The user agrees. The VC starts the suitable e-learning educational and informative contents for smoking cessation by providing information related to the importance of correcting smoking habits. **Test:**

	- The technician verifies that the Virtual Coach asks the user if he wants to participate in a virtual lesson on smoking cessation - The user agrees - The technician checks the logfile to verify that IF positive answer, THEN the Virtual Coach opens e-learning service and launches the lesson

<u>Test documentation:</u>

Integration:

The test involves the avatar base UI on the tablet, the dialog manager, the KRF, and the e-learning service (CS4). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving the e-learning content by the user on the UI running on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 94 below.

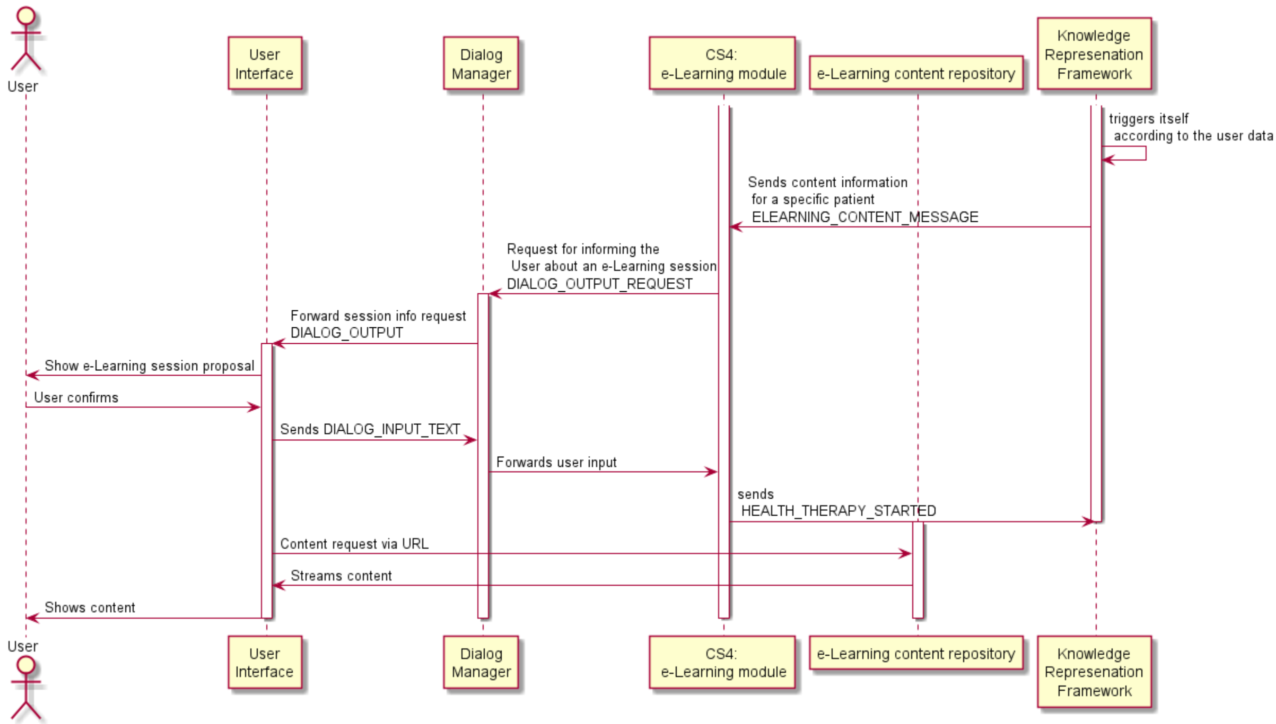

Figure 94: Data flows for test A-18 HF – CS4 – R5-2

Test execution:

- **Trigger**: a technician at FZI triggers the test by setting the appropriate thresholds needed to invoke the e-learning message by the reasoner.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** It is tested if the e-learning session is established on the UI.

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
An ELEARNING_CONTENT_MESSAGE is generated manually within the KRF to trigger an e-learning session.	The output is a HEALTH_THERAPY_STARTED message sent back to the KRF when the user as confirmed to start the session.	Clinicians are satisfied; the test reflects their expectations.

Test summary:
We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 94 were supervised by technical people by help of the log files.

<table>
<tr><td rowspan="2">Services: SS2 Agenda</td><td>Requirement: R3-1 Coach main interactive application, the avatar</td></tr>
<tr><td>Context:
In the past week the user reported a higher number of cigarettes smoked. The VC reminds the user about the risk of smoking

Test:
- Data simulating a higher number of cigarettes smoked during the past days are inserted into the system
- The technician verifies that IF high number of cigarettes, THEN the VC reminds the user the risk of smoking</td></tr>
</table>

<u>**Test documentation:**</u>

Integration:

The test involves the avatar base UI on the tablet, the notification manager service (CS6), die dialog manager and the reasoner. The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of the reminder for medication intake by the end-user UI on the tablet.

Test setup - precondition:

Simulated information about the number of cigarettes smoked are modelled in the knowledge layer. The information stored is compared to previous consumption by the reasoner and the reminder is triggered accordingly.

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 95 below.

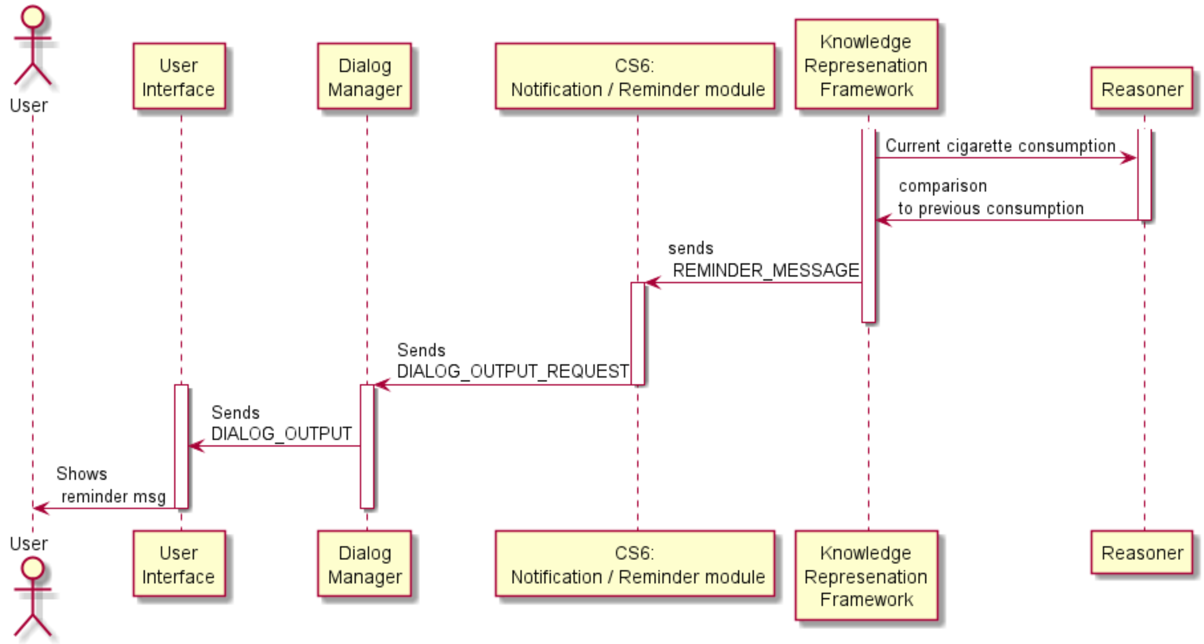

Figure 95: Data flows for test A-18 HF –SS2 – R3-1

Test execution:

- **Trigger:** the reminder is triggered by the KRF manually for the test.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** The reminder has been shown on the tablet via speech output and a textual reminder message.

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
A REMINDER_MESSAGE is triggered manually within the KRF without confirmation option.	The output is the reminder message presented on the UI in textual and verbal form.	Clinicians are satisfied; the test reflects their expectations.

Test summary:
We validated the technical components in an integrated environment at the AIT tech lab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted Figure 95 were supervised by technical people by help of the log files.

7.3.9 Test case Activity A-19 HF: Anxiety and depression reduction

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Medical questionnaires	CS-7	R5-7
User feeling	CS-8	R5-6
Social monitoring	DS-8	R2-10
Detection of emotional state	DS-9	R2-10
Agenda	SS-2	R3-1, R3-7

Test case

Activity: ANXIETY AND DEPRESSION REDUCTION

Initial setting (from D1.3): As part of the First narrative/Use Case #7 and #8, Mrs. Elena profile's at discharge from the hospital composed by

ONTOLOGY (from D1.3/D4.2):

- "**Patient profile**": pathology (e.g. heart failure), clinical data depicting the clinical syndrome
- **"Activity":** Supervision of resistance training

TECHNOLOGY from (D7.2): - Tablet	
Services: **SS2 Agenda**	*Requirement:* **R3-7 Agenda interface**
	Context*:* The user asks the VC to consult the agenda in order to carry out the established activity. **Test:** *Already tested in SD A-1 Home-based Motor Activities, Services:* SS-2Agenda, *Requirement:* R3-7Agenda interface
Services: **CS-7** **Medical questionnaires**	*Requirement:* **R5-7 Questionnaires**
	Context: Before starting with the planned rehabilitation activities, the VC displays to the user a scale to evaluate the mood. Since the user is elderly, the Hospital Anxiety and Depression Scale (HADS) is displayed. The user self-administers the scale in a few minutes through the tablet or TV screen. The VC asks for confirmation and saves the result obtained. **Test:** *Already tested in SD A-8 Monitoring mood, Services:* CS-7Medical questionnaires, *Requirement:* R5-7 Questionnaires
Services: **CS8 User feeling**	*Requirement:* **R5-6 User feelings**
	Context: VC asks questions directly to the user regarding its subjective wellbeing, scoring on a 5-point Likert scale. **Test:** *Already tested in SD A-2 Coaching for an active lifestyle, Services:* CS-8 User feeling, *Requirement:* R5-6 User feelings

Services: **DS-8 Social monitoring**	*Requirement:* **R2-10 Social monitoring**
	Context: Mood assessment is a complex matter that cannot be limited only to the administration of a scale. The VC then collects information about the amount of time users are alone at home, with other people or going out **Test:** *Already tested in PD A-8 Monitoring mood, Services:* DS 9 Detection of emotional state, *Requirement:* R2-10 Social monitoring

Adjustment: the test definition is incorrect; mood cannot be inferred from social interactions. This test needs a reformulation.

Services: **DS 9 Detection of emotional state**	*Requirement:* **R2-10 Social monitoring**
	Context: The VC analyses user's face and establishes his/her emotional status and then compares the results obtained from the HADS and the subjective responses to have a more accurate mood assessment. **Test:** - The technician checks the logfiles to verify that, at the end of the self-evaluation, the VC analyses user's face and establishes his emotional status - The technician checks into the database that the VC recorded a consistency between the results obtained from the HADS and from the subjective evaluation.

Test documentation:

Integration:

The test involves the emotion recognition module of the avatar-based UI which is not yet integrated into the vCare UI, but tested as a separated application at this state. For the emotion recognition using facial images, the third party 3DiVi Face SDK is used. The SDK currently supports four states: Happy, Neutral, Angry and Surprised.

Test setup - precondition:

At this stage the feasibility of integration into the vCare app and the performance of the SDK has been evaluated and tested. A screenshot of the demo application with the integrated SDK is shown below in Figure 96.

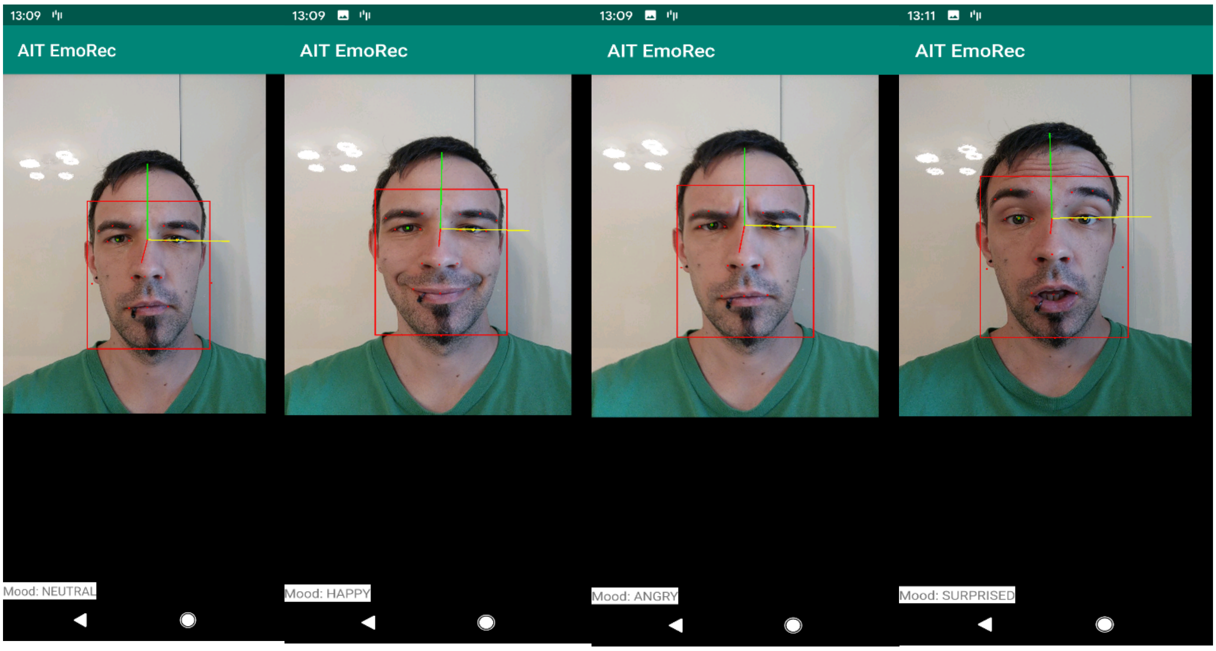

Figure 96: Screenshot of the emotion recognition demo application

Test execution:

- **Trigger:** the tester manually triggers the measuring of the emotional state based on the facial image on a mobile device.
    - **Integration test:** The SDK could be integrated in an app
    - **Interaction test:** The app measures the emotional state.

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
The trigger is the tester holding the device in front of his face so that it can be recognized by the app	The output is the emotional state of the user.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the function of the emotion recognition module at the AIT TechLab.

Services: **SS2 Agenda**	*Requirement:* **R3-1 Coach main interactive application, the avatar**
	Context: User is sitting on the couch after having breakfast and his morning pills. His emotional state is toward depressed. The avatar through direct verbal interaction with the user asks the patient if he wants to know what upcoming cultural events are scheduled today around his location. The user accepts. **Test:** - Data simulating user depression state are inserted into the system - The technician checks the logfiles to verify that IF user is depressed, THEN the VC sends a verbal reminder to take a look at the possible cultural events of this evening around user's location.

Test documentation:

Integration:

The test involves the avatar base UI on the tablet, the notification manager service (CS6), die dialog manager and the reasoner. The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of the reminder for medication intake by the end-user UI on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 97 below.

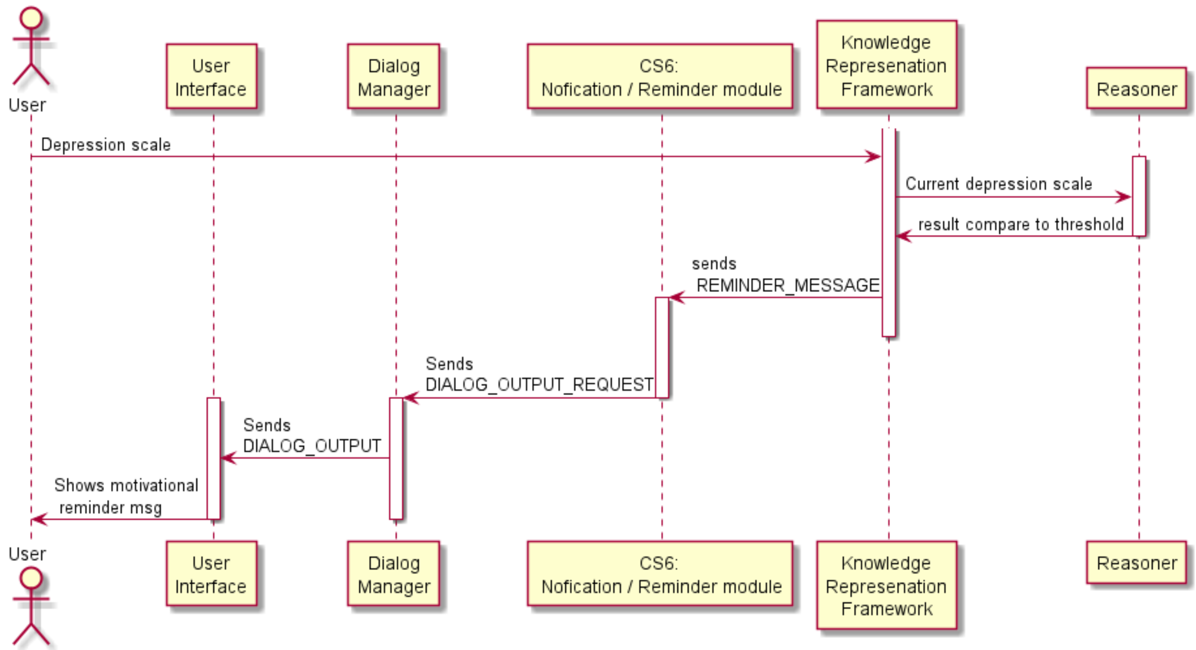

Figure 97: Data flows for test A-19 HF –SS2

Test execution:

- **Trigger:** the reminder is triggered by the KRF manually for the test.
  - **Integration test:** the message flow through all components was tested.
  - **Interaction test:** The reminder has been shown on the tablet via speech output and a textual reminder message.

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
A REMINDER_MESSAGE without confirmation option is triggered manually within the KRF	The reminder is shown on the UI in verbal and textual form.	Clinicians are satisfied; the test reflects their expectations.

Test summary:
We validated the technical components in an integrated environment at the AIT tech lab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 97 were supervised by technical people by help of the log files.

7.4 Activity test Report–Ischemic heart disease

A Test case for each one of the following Activities related to Ischemic Heart Disease (IHD) listed in D1.4 – Annex 6.6 has been defined and will be described henceforth:

Table 26 - List of Activities related to Ischemic Heart Disease (IHD) as listed in D1.4 - Annex 6.6

Activity (A)	A #	Other Paths	Medical Use Case UC #	Needs	Medical Priority (1=high, 4=low)
E-learning	A-3	SD, PD, HF	UC1, UC2, UC5, UC6, UC7, UC9, UC10, UC11	Physical therapy, Cognitive training, Risk Factor Modification.	3
Monitoring mood	A-8	SD, PD	UC3, UC4, UC5, UC13	Emotional and Social rehabilitation	3
Aerobic physical activity	A-13	HF	UC9, UC11	Physical therapy	1
Resistance training	A-14	HF	UC10, UC11, UC13, UC14	Physical therapy	2
Medication intake support	A-15	PD, HF	UC5, UC7, UC12	Pharmacological intervention	2
Weight control	A-17	HF	UC11	Risk Factor Modification	2
Smoking cessation activity	A-18	HF	UC10, UC14	Risk Factor Modification	2
Anxiety and depression reduction	A-19	HF	UC7, UC9, UC10, UC13	Emotional and Social rehabilitation	4
Walking physical activity	A-20		UC11, UC13, UC14	Physical therapy	3
Alcohol reduction	A-21		UC13, UC14	Risk Factor Modification	4

7.4.1 Test case Activity A-3 IHD: E-learning

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
E-Learning	CS-4	R5-2
Detection of activities of daily living	DS-7	R2-8, R2-9
Agenda	SS-2	R3-1, R3-7
Standby	SS-3	R3-11

Test case

<table>
<tr><td colspan="2">

Activity: E-LEARNING

</td></tr>
<tr><td colspan="2">

Initial setting (from D1.3): As part of the First narrative/Use Case #11 and #12, Kirsten's profile's after finishing hospital-controlled 12-week mandatory cardiac rehabilitation composed by

ONTOLOGY (from D1.3/D4.2):

- "**Patient profile**": pathology (non-ST elevation acute myocardial infarction), clinical data depicting the clinical syndrome, clinical classification of patient at end of phase II rehabilitation (e.g. "obesity")
- "**Clinical State**": Weight, height, waist and hip circumference, daily calorie intake (including contents of fat, carbohydrates, and proteins), physical activity (calories spent)
- "**Evidence Indicators**": Educational and e-learning time spent.
- **"Activity":** Supervision of physical activity and calorie intake
- **"Time Event":** Once every week

REASONER (from D1.3):

- Rules for weight control (Weight monitoring initially one measurement a day (later adjust to patient's needs, according to abnormal increase or decrease).
- Rules for physical activity (Monitoring of daily activity outdoor or indoor steps/stairs continuous when using the sensors)

TECHNOLOGY from (D7.2):

- Tablet
- Activity tracker

</td></tr>
<tr><td rowspan="2">

Services: **DS-7**
Detection of activities of daily living

</td><td>

Requirements: **R2-9 Deviation behaviour detection**

</td></tr>
<tr><td>

Context:
Detection of habits. Possible deviations from normal behaviour (e.g. not walking 30 minutes every day, not following prescribed physical activity plan, increased calorie intake, and/or weight gaining) are detected and interpreted by the Virtual Coach to activate e-learning activity.

Test:

- Already tested in SD A-3 E-Learning, Services: DS-7 Detection of activities of daily living, Requirement: R2-9 Deviation behaviour detection

</td></tr>
<tr><td rowspan="2">

Services: **SS-2**
Agenda

</td><td>

Requirement: **R3-1 Coach main interactive application, the avatar**

</td></tr>
<tr><td>

Context:
The VC proposes relevant e-learning session according to detected activities or deviations. Acceptance of user.

Test:

- The technician verifies that the reasoner informs the user that a new e-learning lesson is available on the tablet
- The user accepts to start the lesson
- The technician checks the database entries to verify the storage of the positive answer

</td></tr>
</table>

Test documentation:

Integration:

The test involves the avatar base UI on the tablet, the dialog manager, the KRF, and the e-learning service (CS4). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving the e-learning content by the user on the UI running on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 98 below.

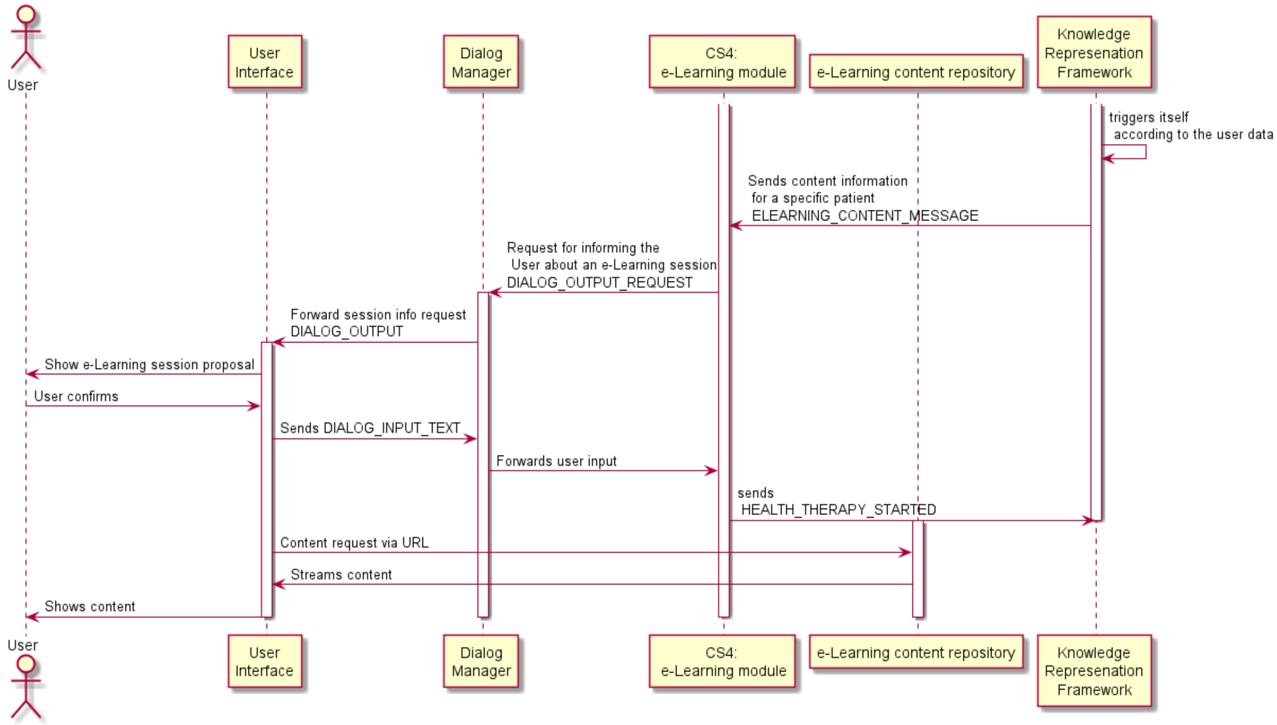

Figure 98: Data flows for test A-3 IHD – SS2

Test execution:

- **Trigger**: a technician at FZI triggers the test by setting the appropriate thresholds needed to invoke the e-learning message by the reasoner.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** It is tested if the e-learning session is established on the UI.

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
A ELEARNING_CONTENT_MESSAGE is triggered within the KRF.	The output is the confirmation in form of a HEALTH_THERAPY_STARTED message to indicate that the user has confirmed to perform the session.	Clinicians are satisfied; the test reflects their expectations.

Test summary:
We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 98 were supervised by technical people by help of the log files.

Services: **CS-4 E-Learning**	*Requirement*: **R5-2 E-learning**
	Context: The VC starts the suitable e-learning educational and informative contents for heart-healthy diet instructions, arguments for conducting exercises and plays it on the tablet. **Test:** *Already tested in SD A-3 E-Learning (Test 2: Physical therapy), Services:* CS-4 E-Learning, *Requirement*: R5-2 E-learning
Services: **SS-3 Standby**	*Requirement:* **R3-11 Standby mode**
	Context: Patient decides not having any kind of interaction due to e.g. going on holiday or having visitors **Test:** *Already tested in PD A-2 Coaching for an active lifestyle, Services:* SS-3 Standby mode, *Requirement:* R3-11 Standby mode

7.4.2 Test case Activity A-13 IHD: Aerobic physical therapy

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Physical training	CS-1	R5-8
Health status	CS-2	R5-5

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Rehabilitation coach	CS-5	R3-6, R4-6
Intelligent notifications scheduler	CS-6	R2-7, R2-8, R3-1, R3-6, R5-3, R5-4
Agenda	SS-2	R3-1, R3-7

Test case

<table>
<tr><td colspan="2">Activity: AEROBIC PHYSICAL THERAPY</td></tr>
<tr><td colspan="2">Initial setting (from D1.3): As part of the First narrative/Use Case #11 and #12, Kirsten's profile's after finishing hospital-controlled 12-week mandatory cardiac rehabilitation composed by

ONTOLOGY (from D1.3/D4.2):

– “Patient profile”: pathology (non-ST elevation acute myocardial infarction), clinical data depicting the clinical syndrome, clinical classification of patient at end of phase II rehabilitation (e.g. “obesity”)
– “Clinical State”: Weight, height, waist and hip circumference, physical activity (calories spent), exercise capacity (Watt-max test)
– “Evidence Indicators”: Weight, waist circumference, exercise capacity, heart rate, tracking of exercise (e.g. on activity tracker)
– “Activity”: Supervision of physical activity
– “Time Event”: Individualised sessions of at least 30-60 minutes twice/week with intensity of 50-80% of maximal exercise capacity

REASONER (from D1.3):

– Rules for weight control (Weight monitoring initially one measurement a day (later adjust to patient’s needs, according to abnormal increase or decrease).
– Rules for physical activity (Monitoring of daily activity outdoor or indoor steps/stairs continuous when using the sensors)

TECHNOLOGY (from D7.2):

– Sensor based training system (REHABILITY)
– Tablet
– Activity tracker</td></tr>
<tr><td rowspan="2">Services: CS-5 Rehabilitation coach</td><td>Requirement: R3-6 Information interface</td></tr>
<tr><td>Context:
The VC notifies the user that is time to perform an aerobic physical activity based on her personalised rehabilitation plan.

Test:
Already tested in HF A-13 Aerobic physical therapy, Services: CS-5 Rehabilitation coach, Requirement: R3-6 Information interface</td></tr>
</table>

Services: **CS-1 Physical training**	*Requirement*: **R5-8 Physical training**
	Context: The user switches on the REHABILITY and Set-Top Box and performs the recommended activity. **Test:** *Already tested in HF A-13 Aerobic physical therapy, Services: CS-1Physical training, Requirement: R5-8Physical training*
Services: ***CS*-2 Health status**	*Requirements:* **R5-5 Health status**
	Context: Report service to deliver the performing information regarding the exercises results and vital signs **Test:** *Already tested in HF A-13 Aerobic physical therapy, Services: CS-2 Health status, Requirement: R5-5Health status*
Services: **CS-5 Rehabilitation coach**	*Requirement:* **R4-6 Personalized and context-aware interaction and feedback**
	Context: The Virtual Coach delivers messages to the patient with either rewards, suggestion, feedback, alerts, reminders, warnings, messages. **Test:** - The technician verifies that at the end of the training session the VC provides feedback according to results

Adjustments and Specifications during TechLab with medical partners from UMFCD:

The result of an aerobic physical therapy is quantified by the BORG assessment that needs to follow the activity execution. Suggestions, feedback, alerts and reminders will only be based on the evaluated exertion of the patient.

Therefore, the Use Case defined for A-13 IHD: Aerobic physical therapy CS-5 Rehabilitation coach Requirement: R4-6 Personalized and context-aware interaction and feedback refers directly to Activity A-12 HF: Daily motor activity Services: CS-5 Rehabilitation coach Requirement: R4-6 Personalized and context-aware interaction and feedback.

Services: **CS-6 Intelligent notifications scheduler**	*Requirement:* **R5-3 Notifications and reminders**
	Context: At the end of the physical activity, the VC sends to the user the reminder of the next scheduled activity. **Test:**

	- The technician verifies that, at the end of the first scheduled activity, the VC sends a notification reminding the user the second planned activity of the day

Test documentation:

Integration:

The test involves the avatar base UI on the tablet, the notification manager service (CS6), die dialog manager, the physical training module (CS1) and the reasoner. The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of the reminder for the next activity at the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 99 below.

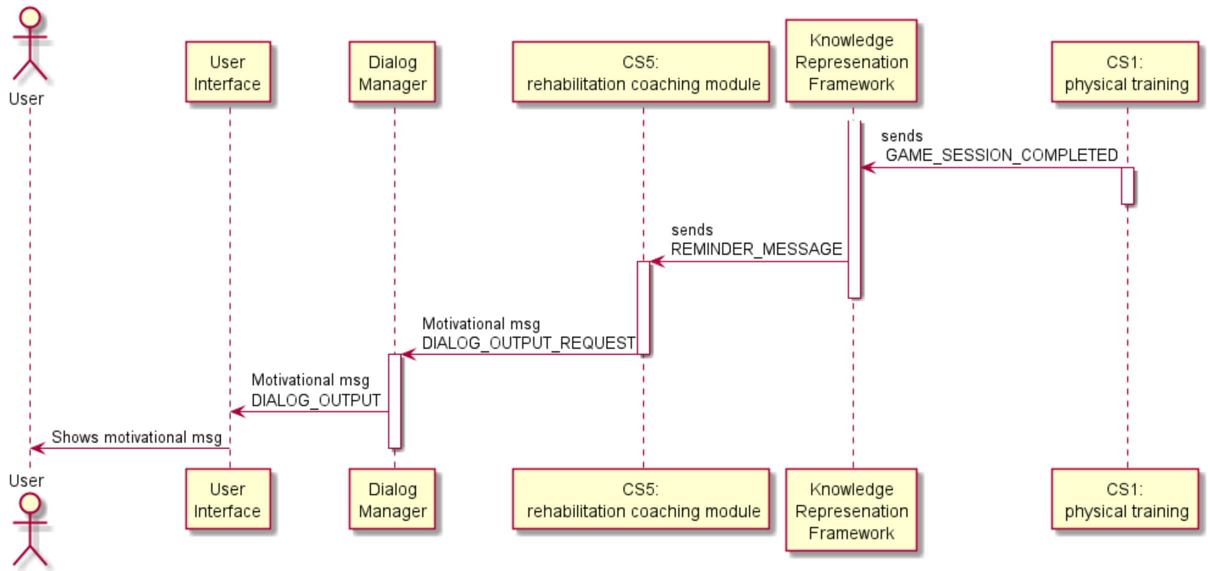

Figure 99: Data flows for test A-13 IHD –CS6

Test execution:

- **Trigger:** a message for indicating that a game session has been ended is generated manually
    - **Integration test:** the message flow through all components was tested.

- **Interaction test:** The reminder has been shown on the tablet via speech output and a textual reminder message.

Test validation:

- The log of the modules is checked if the response could be received.
- The UI is checked visually for the correct output.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
A GAME_SESSION_COMPLETED message is generated manually to trigger a REMINDER_MESSAGE sent by the KRF.	The reminder message is shown on the UI in textual and verbal form.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 99 were supervised by technical people by help of the log files.

Services: **SS-2 Agenda**	*Requirement:* **R3-7 Agenda interface**
	Context: The agenda interface shows the scheduled daily activities. **Test:** *Already tested in SD A-1 Home-based Motor Activities, Services:* SS-2 Agenda, *Requirement:* R3-7 Agenda interface

7.4.3 Test case Activity A-14 IHD: Resistance training

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Physical training	CS-1	R5-8
Health status	CS-2	R5-5

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Rehabilitation coach	CS-5	R3-6, R4-6
Intelligent notifications scheduler	CS-6	R2-7, R2-8, R3-1, R3-6, R5-3, R5-4
User feeling	CS-8	R5-6
Body position detection	DS-2	R2-3
Agenda	SS-2	R3-1, R3-7

Test case

Activity: RESISTANCE TRAINING		
Initial setting (from D1.3): As part of the First narrative/Use Case #11, Kirsten's profile's after finishing hospital-controlled 12-week mandatory cardiac rehabilitation composed by **ONTOLOGY** (from D1.3/D4.2): - "**Patient profile**": pathology (non-ST elevation acute myocardial infarction), clinical data depicting the clinical syndrome, clinical classification of patient at end of phase II rehabilitation (e.g. "obesity") - "**Clinical State**": Weight, height, waist and hip circumference, physical activity (calories spent), exercise capacity (Watt-max test) - "**Evidence Indicators**": Weight, waist circumference, exercise capacity, heart rate, tracking of exercise (e.g. on activity tracker) - **"Activity":** Supervision of resistance training - **"Time Event":** Individualised sessions of at least 30-60 minutes twice/week **REASONER** (from D1.3): - Rules to manage feedback (Rules D1.3 pg. 73, [*Use Case: UC11. Linked Measure: Resistance training game score (to manage Feedback)*]) **TECHNOLOGY** from (D7.2): - Activity tracker - Tablet - Blood pressure monitoring device - Smart-home devices - Sensor based training system (REHABILITY)		
Services: **SS-2 Agenda**	*Requirement:* **R3-1 Coach main interactive application, the avatar**	
	Context: The user asks the VC when is the next resistance training scheduled. **Test:** *Already tested in HF A-14 Resistance training, Services SS-2 Agenda, Requirement R3-1 Coach main interactive application, the avatar*	
Services: **CS-1** **Physical training**	*Requirement*: **R5-8 Physical training**	
	Context: At the scheduled time, the VC starts the suitable games for conducting resistance training and present it to the user via the AVATAR. **Test:** *Already tested in HF A-14 Resistance training, Services: CS-1Physical training, Requirement: R5-8 Physical training*	
Services: **CS-6 Intelligent notifications scheduler**	*Requirement:* **R2-7Home inactivity detection**	
	Context: Half an hour has passed and the VC detects that the user hasn't started his/her chosen training. The smart home system recognizes the user is inactive in the living room and activates the daily timer of physical inactivity.	

	Test: *Already tested in SD A-2 Coaching for an active lifestyle, Services:* DS-1 Location of the patient in the house and home activity/inactivity monitoring, *Requirement :*R2-7 Home inactivity detection
Services: ***CS*-2 Health status**	*Requirements:* **R5-5 Health status**
	Context: During the user's resistance training the VC monitors the user vital parameters and detects a higher HR than designated **Test:** *Already tested in HF A-14 Resistance training, Services: CS-2 Health status, Requirement: R5-5Health status*
Services: **CS-5 Rehabilitation coach**	*Requirement:* **R4-6 Personalized and context-aware interaction and feedback**
	Context: During the training the VC asks the user how she perceives exertion. **Test:** *Already tested in HF A-12 Daily Motor Activity, Services: CS5Rehabilitation coach, Requirement R4-6 Personalized and context-aware interaction and feedback*
Services: **CS-8 User feeling**	*Requirement:* **R5-6 User feelings**
	Context: VC asks questions directly to the user regarding its subjective wellbeing, scoring on a 5-point Likert scale. **Test:** *Already tested in SD A-2 Coaching for an active lifestyle, Services:* CS-8 User feeling, *Requirement:* R5-6 User feelings
Services: DS-2 **Body position detection**	*Requirement*: **R2-3 Body position detection**
	Context: For her next resistance training the user chooses to perform exergames. The VC asks the user to step in front of her TV. **Test:** *Already tested in HF A-14Resistance training, Services:*DS-2Body position detection, *Requirement:* R2-3Body position detection

7.4.4 Test case Activity A-15 IHD: Medication intake support

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Monitoring of vital parameters	DS-5	R7-1, R7-2, R7-3, R7-4, R7-5, R7-6, R7-7
Intelligent notifications scheduler	CS-6	R2-7, R2-8, R3-1, R3-6, R5-3, R5-4
Agenda	SS-2	R3-1, R3-7

Test case

Activity: MEDICATION INTAKE SUPPORT		
Initial setting (from D1.3): As part of the First narrative/Use Case #11 and #12, Kirsten's profile's after finishing hospital-controlled 12-week mandatory cardiac rehabilitation composed by **ONTOLOGY** (from D1.3/D4.2): – "**Patient profile**": pathology (non-ST elevation acute myocardial infarction and diabetes type 2), clinical data depicting the clinical syndrome, clinical classification of patient at end of phase II rehabilitation (e.g. "forgetfulness in taking prescribed medication") – "**Clinical State**": Need of daily medication (treated with as a minimum a platelet inhibitor and a cholesterol lowering drug life-long. Further, in the initial year after the onset of the disease, the patient often receives double platelet inhibition and a beta-blocker) Mrs. Kirsten also need to take injections daily with insulin. – "**Evidence Indicators**": Detection of pills taken (yes/no) from intelligent pillbox. Blood test levels of cholesterol and long-term blood sugar (HbA1c) – **"Activity":** Medication intake reminders and reminders of having blood tests performed – **"Time Event":** Individualised according to prescribed medication. Possibility for personalized settings with daily reminders at four time point e.g. morning, noon, evening, and night. **REASONER** (from D1.3): – Rules for medication reminders = four times a day. – Rules for blood tests = every 3 months. Result of blood test being interpreted by general practitioner according to normal activity. **TECHNOLOGY** from (D7.2): – Tablet – Pillbox		
Services: **SS-2 Agenda**	*Requirement:* **R3-7 Agenda interface**	
	Context*:* The user asks the VC to consult the agenda of the medication established by the caregiver. **Test***:* *Already tested in SD A-1 Home-based Motor Activities, Services:* SS-2 Agenda*, Requirement:* R3-7 Agenda interface	
Services: ***CS***-**6 Intelligent notification scheduler**	*Requirement:* **R5-3 Notifications and reminders**	
	Context: At the scheduled time, the VC starts the reminders of taking prescribed medication via the pillbox **Test:** - Data simulating the scheduled times of medication intake are inserted into the system: Medication intake four times every day i.e. morning, noon, evening, night - The technician verifies that at the scheduled time the VC reminds the user to take medications	

Test documentation:

Integration:

The test involves the avatar base UI on the tablet, the notification manager service (CS6), die dialog manager and the reasoner. The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of the reminder for medication intake by the end-user UI on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 100 below.

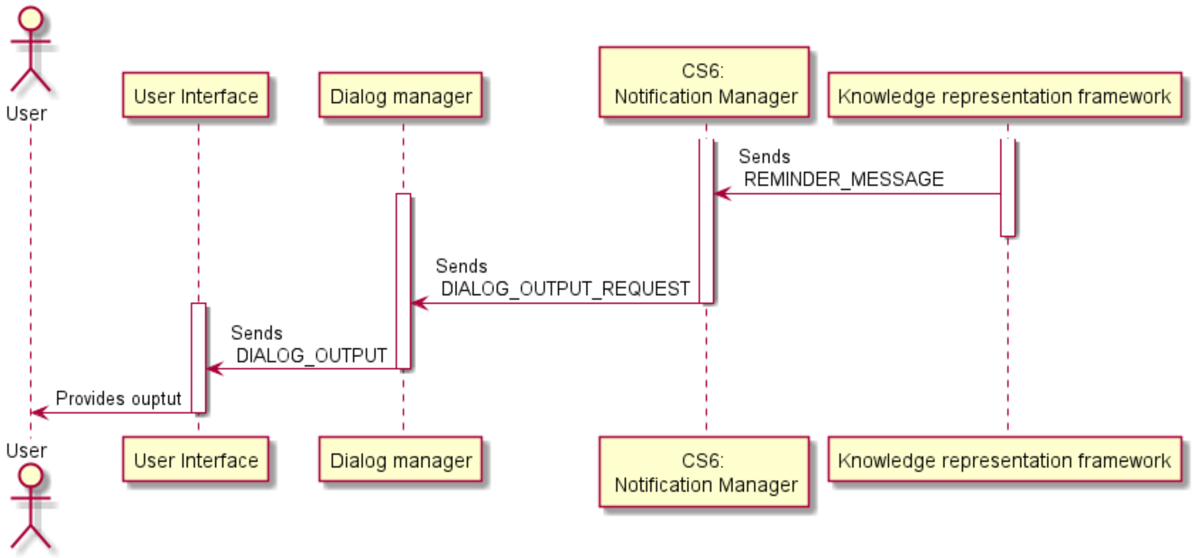

Figure 100: Data flows for test A-15 IHD –CS6

Test execution:

- **Trigger:** the reminder is triggered by the KRF manually for the test.
  - **Integration test:** the message flow through all components was tested.
  - **Interaction test:** The reminder has been shown on the tablet via speech output and a textual reminder message.

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
A REMINDER_MESSAGE is triggered manually within the KRF without confirmation option.	The reminder is shown on the UI in textual and verbal from.	Clinicians are satisfied; the test reflects their expectations.

Test summary:
We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 100 were supervised by technical people by help of the log files.

Services: ***CS-6*** **Intelligent notification scheduler**	*Requirement:* **R3-1 Coach main interactive application, the avatar**
	Context: The VC through direct interaction with the user reminds him/her to monitor vital signs **Test:** - The technician verifies that, after the schedule time of medication intake, the VC reminds the user to monitor also vital parameters

Adjustment: this test is the same as the previous one (A-19 HF –SS2) and differs only in the time of the trigger.

Services: **DS-5 Monitoring of vital parameters**	*Requirement*: **R7-7 Medication adherence monitoring**
	Context: The VC monitors medication adherence and gives different feedbacks according to medication adherence results. **Test:** - The user takes the prescribed medication from the pillbox - The technician verifies the reception of data from the pillbox checking the database entries - The technician checks the logfiles to verify that IF the user has taken the medication, THEN the VC sends a notification with positive feedback AND - The user does not take the medication from the pillbox - The technician verifies the reception of data from the pillbox checking the database entries

	- The technician checks the logfiles to verify that IF the user has not taken the medication, THEN the VC sends a notification remanding to take the medications

Adjustment: the absence of a medication intake monitor makes the execution of this test not possible. The strategy to get information about the medication intake needs to be redefined to a more active interaction with the avatar to survey the patient about the medication intake.

Services: **DS-5 Monitoring of vital parameters**	*Requirement*: **R7-1 Vital signs monitoring**
	Context: The user monitors his vital signs through the activity tracker. **Test:** *Already tested in HF A-16 Vital stats control, Services: DS-5 Monitoring of vital parameters, Requirement: R7-1 Vital signs monitoring*
Services: **DS-5 Monitoring of vital parameters**	*Requirement*: **R7-5 Glucose monitoring**
	Context: The VC reminds the user to monitor glucose twice a day. **Test:** - The technician verifies that, after the schedule time of medication intake, the VC reminds the user to monitor also glucose

Adjustment: the test, as defined, cannot be implemented since the requirement about medication monitoring has changed and it uses a different approach. The new approach asks the patient whether he/she took the medication, but does not follow a strict monitoring to assess adherence. The approach with the glucose monitoring needs a redefinition to detach it from the medication intake.

Services: **DS-5 Monitoring of vital parameters**	*Requirement*: **R7-6 Cholesterol monitoring**
	Context: The VC reminds the user to monitor cholesterol **Test:** - The technician verifies that, after the schedule time of medication intake, the VC reminds the user to monitor also cholesterol

<u>Test documentation:</u>

Integration:

To perform this test, information simulated in the knowledge layer about a scheduled activity "medication_intake" is stored. The planned time is defined under the attribute "timing". The reasoner processes this information stored in the knowledge layer and triggers the corresponding reminder in the coaching service. The test involves the avatar base UI on the tablet, the notification manager service (CS6), die dialog manager and the reasoner. The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of the reminder for medication intake by the end-user UI on the tablet.

Test setup - precondition:

Simulated information about the scheduled activity "medication_intake" are inserted to the knowledge graph. The attribute timing is specified so that the reasoner can compare the current time to the planned schedule for this activity. At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 98.

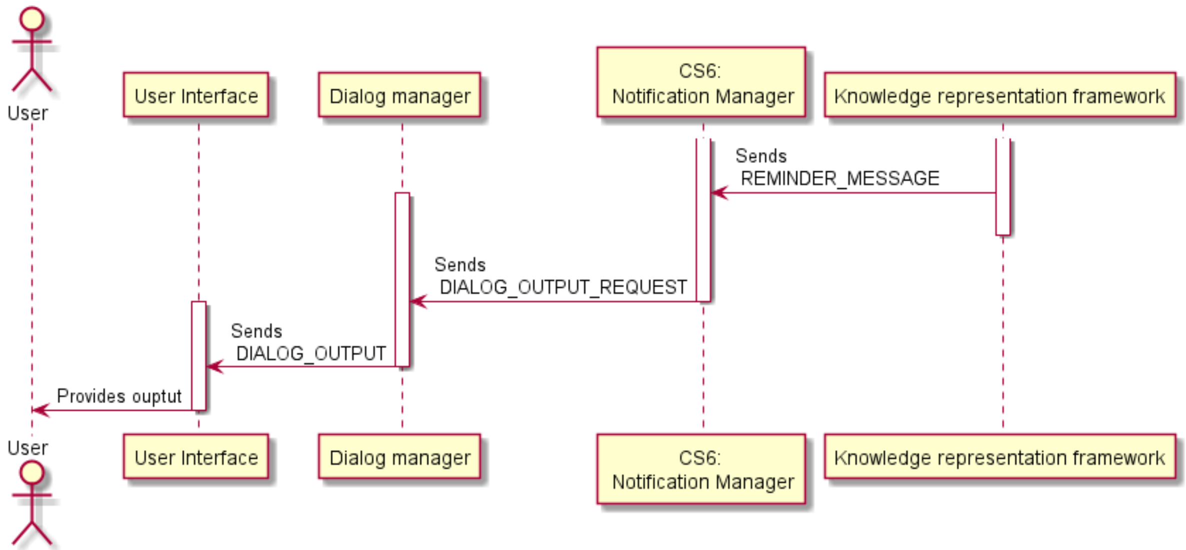

Figure 101: Data flows for test A-15 IHD –DS-5

Test execution:

- **Trigger:** the reminder is triggered by the KRF manually for the test.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** The reminder has been shown on the tablet via speech output and a textual reminder message.

Test validation:

- The reasoners query to the knowledge graph to receive the information about the scheduled activity is validated by the log files
- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
A REMINDER_MESSAGE is triggered automatically within the KRF	The reminder is shown on the UI in textual and verbal from.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 42 were supervised by technical people by help of the log files.

Services: ***CS-6*** **Intelligent notification scheduler**	*Requirements:* **R3-6 Information interface**
	Context: Furthermore, the Virtual Coach reminds the patient to contact general practitioner regarding results of blood tests and actions regarding these results every three months. **Test:** *(Three months, at the time of the test, can be simulated by 5 minutes)* - The technician verifies that each 5 minutes the Virtual Coach promotes the user to have cholesterol and long-term blood sugar (HbA1c) measured in blood tests at the local laboratory - The technician verifies that IF the user accepts, THEN the Virtual Coach launches message of consulting general practitioner for obtaining result from blood tests

<u>Test documentation:</u>

Integration:

The test involves the avatar base UI on the tablet, die dialog manager as part of CS6 and the reasoner (the KRF). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is a reminder to be shown on the UI for consulting the general practitioner. The message flow for this test consists of multiple reminder message flows.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 102 below.

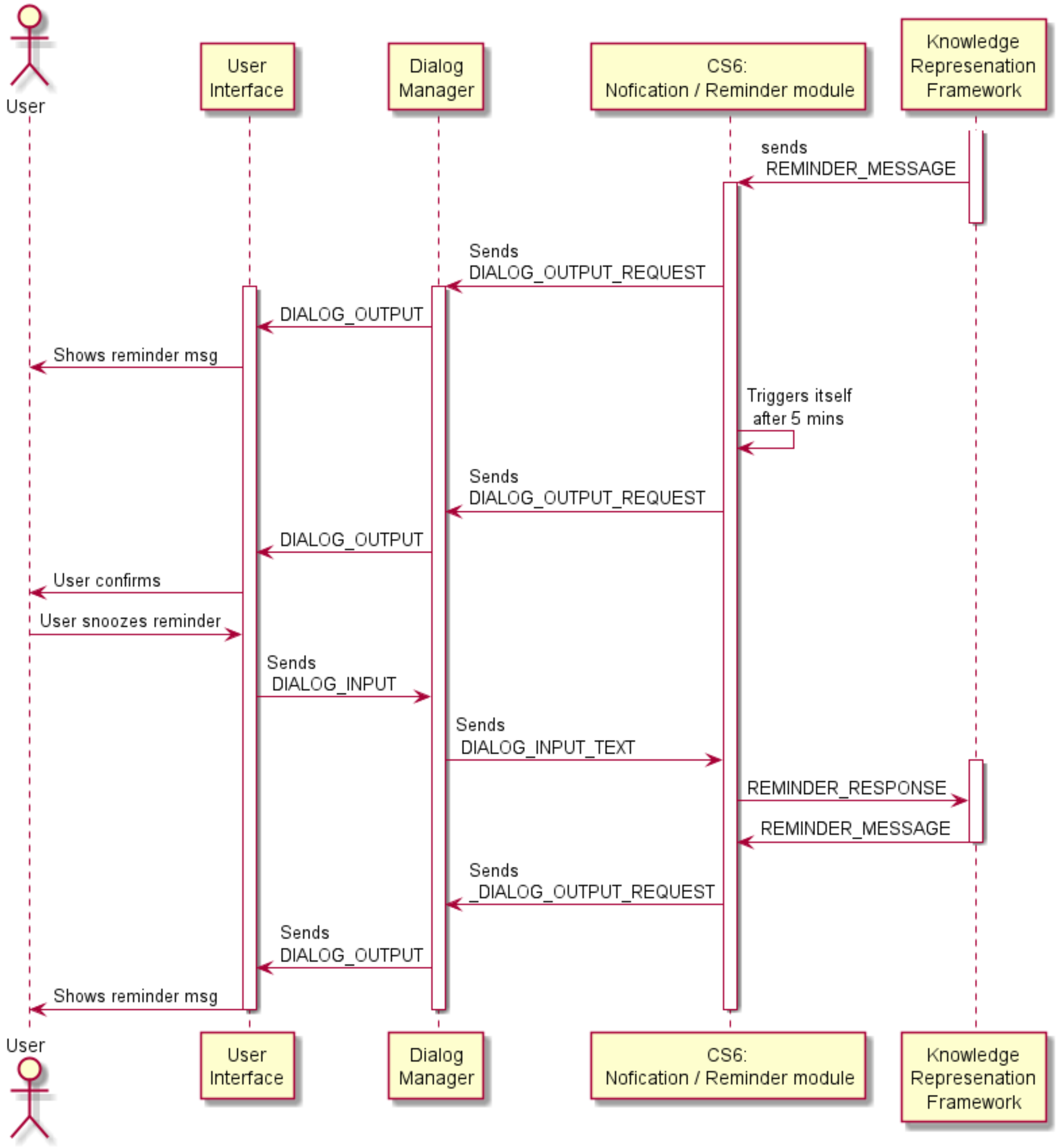

Figure 102: Data flows for test A-15 IHD –CS6

Test execution:

- **Trigger:** the reminder is triggered manually for the test.
  - **Integration test:** the message flow through all components was tested.
  - **Interaction test:** The reminder has been shown on the tablet via speech output and a textual reminder message

Test validation:

- The log of the end-user UI is checked if the reminder message could be received.
- The KRF is checked if the trigger has been created correctly

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
For the text, a REMINDER_MESSAGE with confirmation options is triggered manually by the KRF.	Due to no response by the user, another reminder is generated after the defined delay (5mins). After the confirmation another reminder is shown.	Clinicians are satisfied; the test reflects their expectations.

Test summary:
We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 102 were supervised by technical people by help of the log files.

7.4.5 Test case Activity A-17 IHD: Weight control

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Health status	CS-2	R5-5
E-Learning	CS-4	R5-2
Agenda	SS-2	R3-1, R3-7

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Standby	SS-3	R3-11

Test case

<table>
<tr><th colspan="2">Activity: WEIGHT CONTROL</th></tr>
<tr><td colspan="2">Initial setting (from D1.3): As part of the First narrative/Use Case #11 and #12, Kirsten's profile's after finishing hospital-controlled 12-week mandatory cardiac rehabilitation composed by

ONTOLOGY (from D1.3/D4.2):
– "Patient profile": pathology (non-ST elevation acute myocardial infarction and diabetes type 2), clinical data depicting the clinical syndrome, clinical classification of patient at end of phase II rehabilitation (e.g. "obesity")
– "Clinical State": Need of weight loss and maintenance of weight loss.
– "Evidence Indicators": Detection of increase in weight
– "Activities": E-learning activities regarding heart-healthy diet and exercises, calorie-intake monitoring, and reports of goals achieved
– "Time Event": Once every week

REASONER (from D1.3):
– Rules for weight control (Weight monitoring initially one measurement a day (later adjust to patient's needs, according to abnormal increase or decrease).

TECHNOLOGY (from D7.2):
– Tablet
– Weight scale
– Object detector
– Activity tracker</td></tr>
<tr><td rowspan="2">Services: CS-2 Health status</td><td>Requirements: R5-5 Health status</td></tr>
<tr><td>Context:
Report service to deliver the performing information regarding the weight loss result and goals achieved

Test:

Already tested in HF A-17 Weight control, Services: CS-2 Health status, Requirements: R5-5 Health status</td></tr>
<tr><td>Services: SS-2 Agenda</td><td>Requirement: R3-1 Coach main interactive application, the avatar</td></tr>
<tr><td></td><td>Context:
The VC propose relevant e-learning session according to detected activities or deviations. Acceptance of user.</td></tr>
</table>

	Test: *Already tested in IHD A-3E-learning, Services: SS-Agenda, Requirement: R3-1Coach main interactive application, the avatar*
Services: **CS-4 E-Learning**	*Requirement*: **R5-2 E-learning**
	Context: The VC starts the suitable e-learning educational and informative contents for heart-healthy diet instructions, arguments for conducting exercises and plays it on the tablet. **Test:** *Already tested in HF A-17 Weight control, Services: CS-4 E-Learning, Requirement: R5-2 E-learning*
Services: **SS-3 Standby**	*Requirement:* **R3-11 Standby mode**
	Context: Patient decides not having any kind of interaction due to e.g. going on holiday or having visitors **Test:** *Already tested in HF A-3 E-learning, Services:* SS-3 Standby, *Requirement:* R3-11 Standby mode

7.4.6 Test case Activity A-18 IHD: Smoking cessation activity

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
E-Learning	CS-4	R5-2
Agenda	SS-2	R3-1, R3-7

Test case

Activity: SMOKING CESSATION ACTIVITY
Initial setting (from D1.3): As part of the Second narrative/Use Case #13 and #14, Jens' profile's after finishing hospital-controlled 12-week mandatory cardiac rehabilitation composed by **ONTOLOGY** (from D1.3/D4.2):

<table>
<tr><td colspan="2">

- “**Patient profile**”: pathology (ST elevation acute myocardial infarction complicated with episode of cardiac arrest), clinical data depicting the clinical syndrome, clinical classification of patient at end of phase II rehabilitation (e.g. “heavy smoking profile”)
- “**Clinical State**”: Need of smoking cessation
- “**Evidence Indicators**”: Detection of nicotine dependency (Fagerström's test)
- **“Activities”:** E-learning activities regarding smoking cessation programs
- **“Time Event”:** E-learning once every week, Fagerström's test once every month

REASONER (from D1.3):

- Rules for smoking cessation = performance of Fagerström's test once every month. According to nicotine dependency level 0-10 increase/decrease frequency of e-learning sessions

TECHNOLOGY from (D7.2):

- Tablet

</td></tr>
<tr><td>Services: SS-2 Agenda</td><td>Requirement: R3-7 Agenda interface</td></tr>
<tr><td></td><td>Context:
The agenda interface shows the scheduled daily activities and propose relevant e-learning session according to detected activities or deviations

Test:
Already tested in SD A-1 Home-based Motor Activities, Services: SS-2Agenda, Requirement: R3-7Agenda interface</td></tr>
<tr><td></td><td>Requirement: R3-1 Coach main interactive application, the avatar</td></tr>
<tr><td></td><td>Contest:
The VC asks for detection of nicotine dependency every month. Acceptance of user.

Test:

- The technician verifies that the VC asks questions for detection of nicotine dependency at the scheduled time.
- The user answers.
- The technician verifies the correct storage of user’s answers by checking the database entries</td></tr>
</table>

<u>Test documentation:</u>

Integration:

The test involves the avatar base UI on the tablet, the notification manager service (CS6), die dialog manager and the reasoner (the KRF). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of the message response from the user at the KRF.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 103 below.

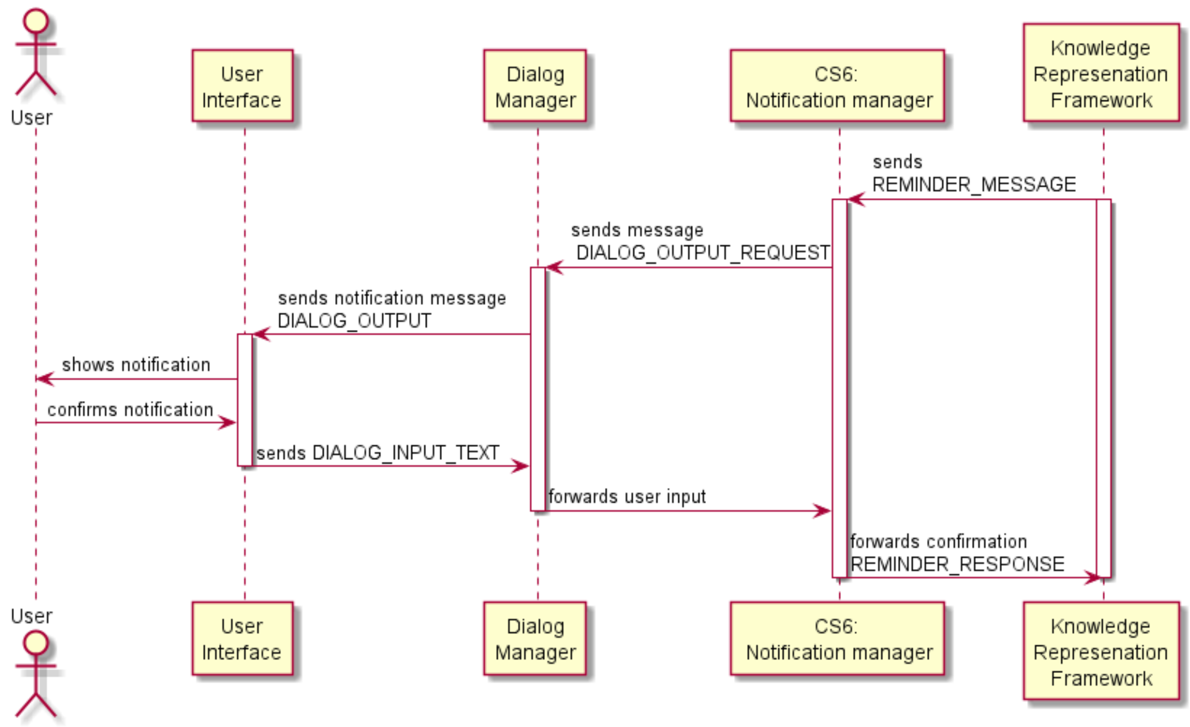

Figure 103: Data flows for test A-18 IHD – SS2

Test execution:

- **Trigger:** the reminder is triggered by the KRF manually for the test.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** The massage has been shown on the tablet via speech output and a textual reminder message and the user can choose among the options provided (“Are you nicotine dependent?” – Answers: “Yes” or “No”)

Test validation:

- The log of the end-user UI is checked if the response could be received.
- The KRF is checked if the response has been received

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)

A REMINDER_MESSAGE is generated within the KRF with confirmation options	The reminder is presented in the UI and the selected confirmation option ("YES"). The response is then sent back to the KRF.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 103 were supervised by technical people by help of the log files.

Services: **CS-4 E-Learning**	*Requirement*: **R5-2 E-learning**
	Context: If the VC detects deviation from normal behaviour, the VC proposes a suitable e-learning educational and informative contents with smoking cessation program and plays it on the tablet. **Test:** *Already tested in HF A-18 Smoking cessation activity, Services: CS-4 E-Learning, Requirement: R5-2 E-learning*
Services: **SS-3 Standby**	*Requirement:* **R3-11 Standby mode**
	Context: Patient decides not having any kind of interaction due to e.g. going on holiday or having visitors **Test:** *Already tested in HF A-3 E-learning, Services:* SS-3 Standby, *Requirement:* R3-11 Standby mode

7.4.7 Test case Activity A-19 IHD: Anxiety and depression reduction

Services and Requirements enhancing the Activity

Service Needs (WP5)		**Functional Requirements (WP7)**
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Medical questionnaires	CS-7	R5-7

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
User feeling	CS-8	R5-6
Social monitoring	DS-8	R2-10
Detection of emotional state	DS-9	R2-10
Agenda	SS-2	R3-1, R3-7

Test case

<table>
<tr><th colspan="2">Activity: ANXIETY AND DEPRESSION REDUCTION</th></tr>
<tr><td colspan="2">Initial setting (from D1.3): As part of the Second narrative/Use Case #13 Jens' profile's after finishing hospital-controlled 12-week mandatory cardiac rehabilitation composed by
ONTOLOGY (from D1.3/D4.2):
– "Patient profile": pathology (ST elevation acute myocardial infarction complicated with episode of cardiac arrest), clinical data depicting the clinical syndrome, clinical classification of patient at end of phase II rehabilitation (e.g. "Anxiety of recurrence of a myocardial infarction or cardiac arrest")
– "Clinical State": Reduce level of anxiety
– "Evidence Indicators": Level of depression (scored by HADS questionnaire)
– "Activities": Reduce level of anxiety
– "Time Event": free (no predefined scheduled)
REASONER (from D1.3):
– Rules to reduce level of anxiety (Rules D1.3 pg. 74, [Use Case: UC31. Linked Measure: emotive status])
TECHNOLOGY from (D7.2):
– Tablet</td></tr>
<tr><td>Services: SS2 Agenda</td><td>Requirement: R3-7 Agenda interface</td></tr>
<tr><td></td><td>Context: The user asks the VC to consult the agenda in order to carry out the established activity.

Test:

Already tested in SD A-1 Home-based Motor Activities, Services: SS-2Agenda, Requirement: R3-7Agenda interface</td></tr>
<tr><td rowspan="2">Services:CS-7

Medical questionnaires</td><td>Requirement: R5-7 Questionnaires</td></tr>
<tr><td>Context:
Before starting with the planned rehabilitation activities, the VC displays to the user a scale to evaluate the mood. Since the user suffers from anxiety of</td></tr>
</table>

	recurrence of a myocardial infarction or cardiac arrest, the Hospital Anxiety and Depression Scale (HADS) is displayed. The user self-administers the scale in a few minutes through the tablet or TV screen. The VC asks for confirmation and saves the result obtained. **Test:** *Already tested in SD A-8 Monitoring mood, Services:* CS-7Medical questionnaires, *Requirement:* R5-7 Questionnaires
Services: **CS8 User feeling**	*Requirement:* **R5-6 User feelings**
	Context: VC asks questions directly to the user regarding its subjective wellbeing, scoring on a 5-point Likert scale. **Test:** *Already tested in SD A-2 Coaching for an active lifestyle, Services:* CS-8 User feeling, *Requirement:* R5-6 User feelings
Services: **DS-8 Social monitoring**	*Requirement:* **R2-10 Social monitoring**
	Context: The VC then collects information about the amount of time the user is alone at home, with other people or going out **Test:** *Already tested in HFAHF -8 Monitoring mood, Services:* DS 9 Detection of emotional state, *Requirement:* R2-10 Social monitoring
Services: **DS 9 Detection of emotional state**	*Requirement:* **R2-10 Social monitoring**
	Context: The VC analyses user's face and establishes his emotional status and then compares the results obtained from the HADS and the subjective responses to have a more accurate mood assessment. **Test:** *Already tested in HF A-19Anxiety and depression reduction, Services:* DS 9 Detection of emotional state, *Requirement:* R2-10 Social monitoring
Services: **SS2 Agenda**	*Requirement:* **R3-1 Coach main interactive application, the avatar**
	Context: The VC detects that user is depressed. The avatar through direct verbal interaction with the user asks the patient if he wants to know what upcoming cultural events are scheduled for today around his location. The user accepts. **Test:** *Already tested in HF A-19 Anxiety and depression reduction, Services: SS2 Agenda, Requirement: R3-1 Coach main interactive application, the avatar*

7.4.8 Test case Activity A-20 IHD: Walking physical activity

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Location + activity monitoring	DS-1	R2-1, R2-6, R2-7
Weather	SS-1	R3-10
Rehabilitation coach	CS-5	R3-6, R4-6
Intelligent notifications scheduler	CS-6	R2-7, R2-8, R3-1, R3-6, R5-3, R5-4
Agenda	SS-2	R3-1, R3-7

Test case

Activity: WALKING PHYSICAL THERAPY

Initial setting (from D1.3): As part of the First narrative/Use Case #11 and #12, Kirsten's profile's after finishing hospital-controlled 12-week mandatory cardiac rehabilitation composed by

ONTOLOGY (from D1.3/D4.2):

- "**Patient profile**": pathology (non-ST elevation acute myocardial infarction and diabetes type 2), clinical data depicting the clinical syndrome, clinical classification of patient at end of phase II rehabilitation (e.g. "obesity")
- "**Clinical State**": Weight, height, waist and hip circumference, physical activity (calories spent), exercise capacity (Watt-max test)
- "**Evidence Indicators**": Weight, waist circumference, exercise capacity, heart rate, tracking of exercise (e.g. on Activity tracker)
- **"Activity":** Supervision of physical activity
- **"Time Event":** Once every day

REASONER (from D1.3):

- Rules for walking physical activity. Once every day launching of time to go for a walk for at least 30 minutes. If there is no track of outdoor physical walking activity e.g., from activity tracker Virtual Coach must notify or remind patient to perform activity.

TECHNOLOGY from (D7.2):

- Tablet
- Activity tracker

Services: **SS-2 Agenda**	*Requirement:* **R3-7 Agenda interface**
	Context:

	The user asks the VC to know what upcoming activity are scheduled. The VC understands and processes the user's request. **Test:** *Already tested in SD A-1 Home-based Motor Activities, Services:* SS-2Agenda, *Requirement:* R3-7Agenda interface
Services: ***SS-2*** **Weather**	*Requirements:* **R3-10 Weather info**
	Context: The user asks the VC about current weather conditions. **Test:** *Already tested in SD A-2 Coaching for an active lifestyle, Services SS-1 Weather, Requirement: R3-10 Weather info*
Services: **CS-5 Rehabilitation coach**	*Requirement:* **R3-6 Information interface**
	Context: The VC provides verbally the current information about the weather. **Test:** - The technician checks the logfiles to verify that the VC produces a message to inform the user about the weather condition

Adjustment: this is the same test as already formed in test case A-2 SD – SS1 fulfilling R3.10.

Services: **CS-6 Intelligent notifications scheduler**	*Requirement:* **R3-1 Coach main interactive application, the avatar**
	Context: The VC proposes to the user a walk outside. The user accepts. **Test:** *Already tested in SD A-2 Coaching for an active lifestyle, Services:* CS6 Intelligent notifications/scheduler, *Requirement:* R3-1 Coach main interactive application, the avatar
Services: **DS-1 Location + activity monitoring**	*Requirement*: **R2-6 Activity monitoring**
	Context: The VC keeps track of physical activity during the walk by counting the numbers of steps. **Test:** *Already tested in SD A-2 Coaching for an active lifestyle, Services: DS-1 Location of the patient in the house and home activity/inactivity monitoring, Requirement: R2-6 Activity monitoring*

7.4.9 Test case Activity A-21 IHD: Alcohol reduction

Services and Requirements enhancing the Activity

Service Needs (WP5)		Functional Requirements (WP7)
Services (S)	**S #**	**Requirement Reference # (see D7.4.)**
Medical questionnaire	CS-7	R5-7
User Feeling	CS-8	R5-6
E-Learning	CS-4	R5-2
Agenda	SS-2	R3-1, R3-7

Test case

<table>
<tr><th colspan="2">Activity: ALCOHOL REDUCTION</th></tr>
<tr><td colspan="2">Initial setting (from D1.3): As part of the Second narrative/Use Case #13 and #14 Jens' profile's after finishing hospital-controlled 12-week mandatory cardiac rehabilitation composed by
ONTOLOGY (from D1.3/D4.2):

– "Patient profile": pathology (ST elevation acute myocardial infarction complicated with episode of cardiac arrest), clinical data depicting the clinical syndrome, clinical classification of patient at end of phase II rehabilitation (e.g. "need for alcohol intake reduction")
– "Evidence Indicators": Alcohol intake (self-reported)
– "Activities": E-learning activities regarding alcohol intake reduction
– "Time Event": E-learning once every week, Alcohol status assessment once every month

REASONER (from D1.3):

– Rules for alcohol intake reduction (Rules D1.3 pg. 72, [Use Case: UC14. Linked Measure: weekly maximum drinks (alcohol volume [ml])])

TECHNOLOGY from (D7.2):

– Tablet</td></tr>
<tr><td rowspan="4">Services: SS2 Agenda</td><td>Requirement: R3-7Agenda interface</td></tr>
<tr><td>Context:
The user asks the VC to consult the daily agenda for the next scheduled activity. The VC starts the agenda application and shows the calendar

Test:

Already tested in SD A-1 Home-based Motor Activities, Services: SS-2Agenda, Requirement: R3-7Agenda interface</td></tr>
<tr><td>Requirement: R3-1 Coach main interactive application, the avatar</td></tr>
<tr><td>Context:
The user through direct interaction with the avatar asks to know what upcoming activities are scheduled in his agenda for today.
The VC answers that is time to answer the questionnaire for the weekly alcohol intake assessment

Test:

– The user asks (through the interface) to the VC the next scheduled activity
– The technician verifies that VC answers vocally with a sound message reminding the next agenda appointment: answering the questionnaire for the weekly number of drinks</td></tr>
</table>

<u>Test documentation:</u>

Integration:

The test involves the avatar base UI on the tablet and the agenda service (SS2) in the backend which is connected to the KIOLA platform (caregiver UI) providing the rehabilitation schedule via a REST interface. The communication between the UI and the agenda service is performed via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of agenda items by the end-user UI on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flows for this test are depicted in Figure 104.

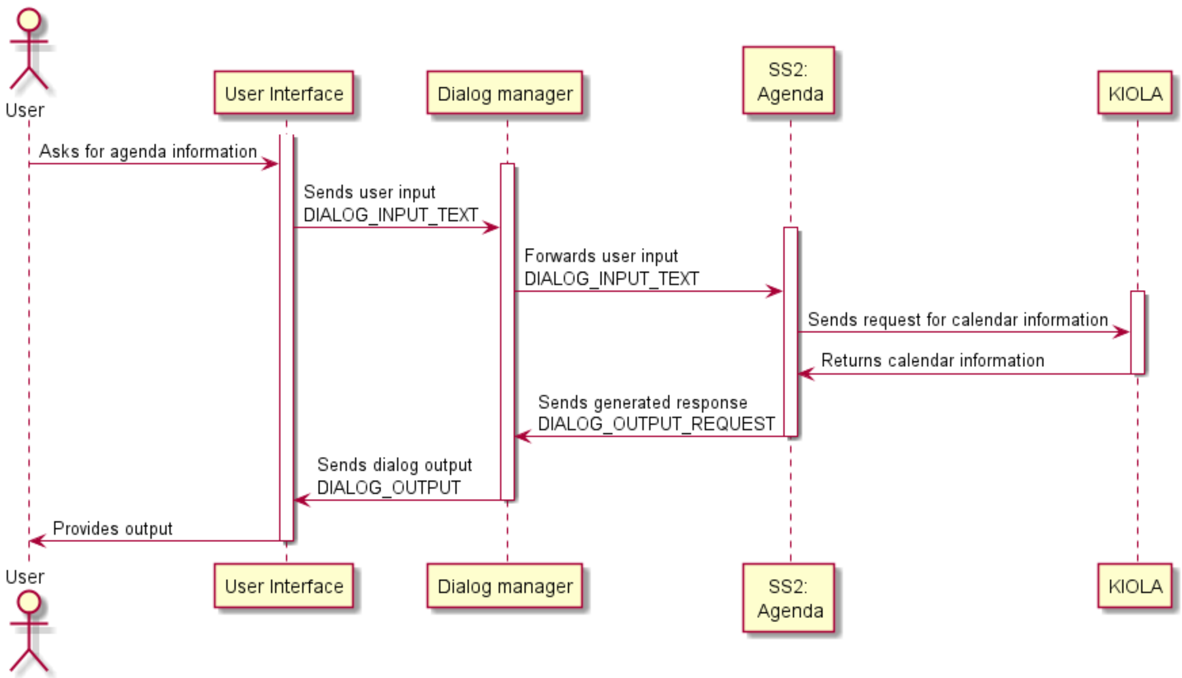

Figure 104: Data flows for test A-21 IHD -- SS2

Test execution:

- **Trigger:** speech input at the tablet for asking for the agenda items: "What's on my agenda today". The dialog manger invokes the agenda service, the agenda service requests the agenda items form the care giver UI (KIOLA) and sends them back to the UI.
    - **Integration test:** the message flow through all components was tested.

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
The test is triggered verbally by asking "What's on my agenda today". The agenda is then requested from the KIOLA platform	The output is a list of agenda items presented within the UI in textual form.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 104 were supervised by technical people by help of the log files.

Services: **CS-7 Medical questionnaires**	*Requirement:* **R5-7 Questionnaires**
	Context: The VC displays to the user a questionnaire to evaluate the weekly number of drinks. The user answers the questionnaires through the tablet. The VC saves the result obtained and compares the results with the thresholds. **Test:** – Data simulating the patient's maximum allowed alcohol volume per week are inserted into the system: 210 ml is the maximum alcohol volume per week – The technician checks the logfiles to verify that the VC shows the questionnaire to assess the alcohol intake – The user answers 230 ml – The technician verifies then the storage of the self-evaluation and that VC compares the number of drinks indicated by the user with the thresholds. – The technician verifies that, according to the comparison, the VC provides the right typology of feedback *(see D1.3 - Rules for alcohol intake reduction)*

<u>Test documentation:</u>

Integration:

The test involves the avatar base UI on the tablet, the dialog manager, the KRF and the medical questionnaire service (CS7). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving of the questionnaire result by the KRF.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 105.

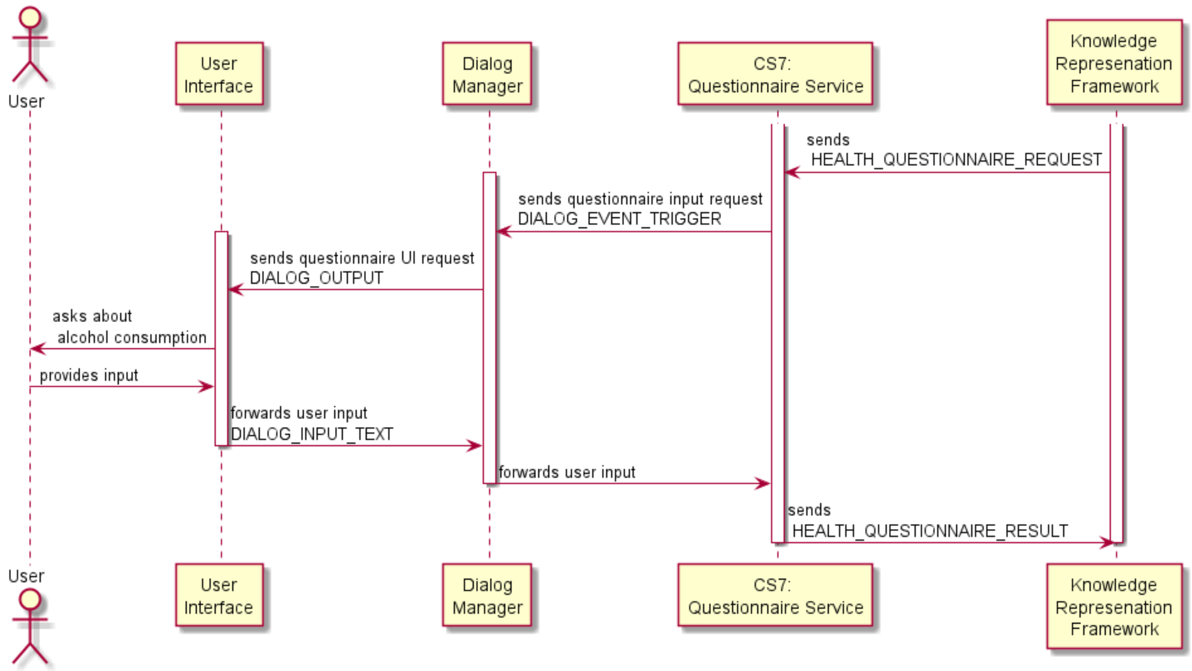

Figure 105: Data flows for test A-21 IHD – CS7

Test execution:

- **Trigger**: The KRF is manually triggered to send the request for the appropriate questionnaire.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** The reminder has been shown on the tablet via speech output and a textual reminder message and the response is received by the reasoner (the KRF)

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
A HEALTH_QUESTIONNAIRE message is triggered manually within the KRF	The output is the selected option by the user which is sent back to the KRF in form of a HEALTH_QUESTIONNAIRE_RESULT message	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 105 were supervised by technical people by help of the log files.

<table>
<tr><td rowspan="2">Services: CS-8 User feeling</td><td>Requirement: R5-6 User feelings</td></tr>
<tr><td>Context:
If the user has indicated a high number of drinks, VC asks questions to the user regarding its subjective wellbeing, scoring with a 5-points Liker scale.

Test:

Already tested in SD A-2 Coaching for an active lifestyle, Services: CS-8 User feeling, Requirement: R5-6 User feelings</td></tr>
<tr><td rowspan="2">Services: CS-4 E-Learning</td><td>Requirement: R5-2 E-learning</td></tr>
<tr><td>Context:
Every time the weekly number of drinks indicated by the user overcomes the maximum number of allowed drinks, the VC proposes to the user an E-learning session on “risks related to alcohol intake and how to reduce alcohol intake”.
The VC proposes to the user the multimedia content. The user accepts and the VC plays the E-learning lesson on a tablet.

Test:

- The technician verifies that IF number of drinks overcomes the threshold, THEN the VC proposes an E-learning lesson on “risks related to alcohol intake and how to reduce alcohol intake”
- The user accepts
- The technician checks the logfile to verify that IF positive answer, THEN the Virtual Coach opens e-learning service and launches the lesson</td></tr>
</table>

Test documentation:

Integration:

The test involves the avatar base UI on the tablet, the dialog manager, the KRF, and the e-learning service (CS4). The communication between all components is established via the MQTT protocol using the vCare MQTT broker. All components have been implemented and all communication channels are set up. The result of the test is the receiving the e-learning content by the user on the UI running on the tablet.

Test setup - precondition:

At this stage, the message formats have been defined and the message structure has been agreed and implemented by all partners involved. The data sent within the messages are taken from a manually generated test user account and represent the data required for this activity. The message flow for this test is depicted in Figure 106.

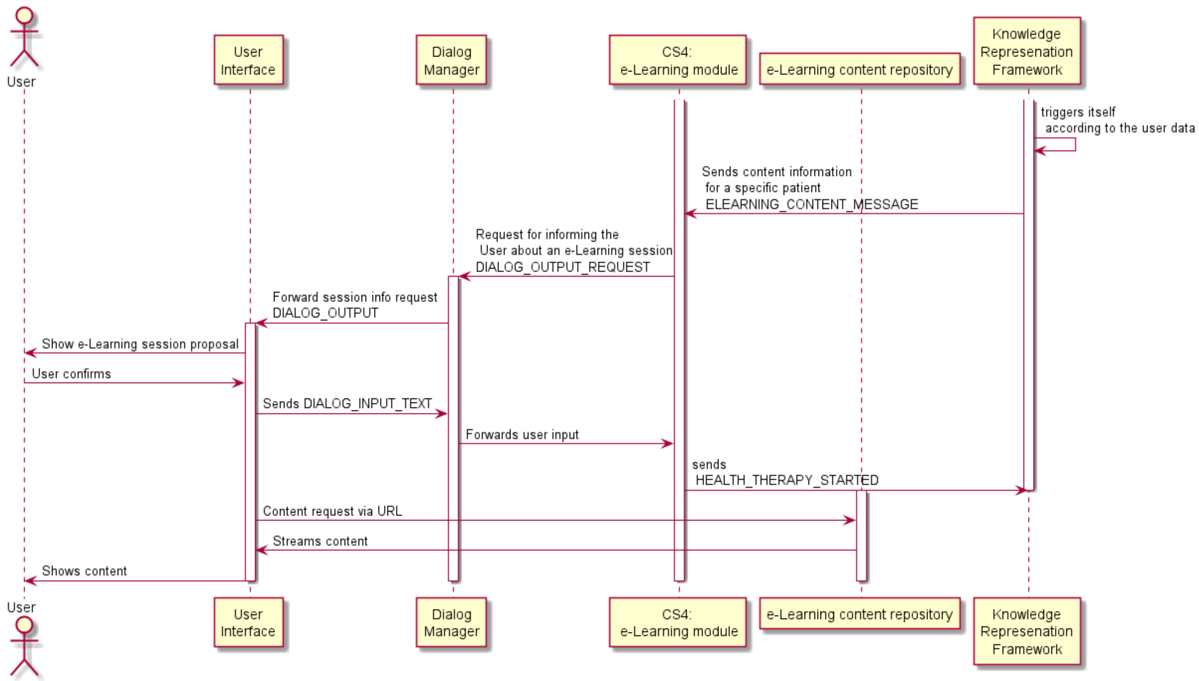

Figure 106: Data flows for test A-21 IHD – CS4

Test execution:

- **Trigger**: a technician at FZI triggers the test by setting the appropriate thresholds needed to invoke the e-learning message by the reasoner.
    - **Integration test:** the message flow through all components was tested.
    - **Interaction test:** It is tested if the e-learning session is established on the UI.

Test validation:

- The log of the end-user UI is checked if the response could be received.

Comment medical partners:

Input summary	Output summary	Comment (Medical Partners)
A ELEARNING_CONTENT_MESSAGE is generated manually to invoke the CS4 to suggest an e-learning session.	After confirmation, a HEALTH_THEAPY_STARTED_MESSAGE is sent back to the KRF.	Clinicians are satisfied; the test reflects their expectations.

Test summary:

We validated the technical components in an integrated environment at the AIT TechLab in cooperation with FZI providing the KRF. The message flows were successful among all involved components. The sending and receiving of all messages as depicted in Figure 106 were supervised by technical people by help of the log files.

8. Conclusion & Next Steps

The document (D1.6) provided a detailed description of the vCare Tech Lab activities, explaining the general goal and the sites in Germany, Spain and Austria, as well as delivering the detailed test documentation of all disease-related activities. As described in D1.5, the test cases performed constitute a comprehensive validation of the embedded systems and functional requirements as foreseen in the implementation plan (D7.4). In summary, the cooperation within the TechLabs offered a good concept to specify the information flow within the vCare architecture and to develop an understanding for the information processing.

The result of the Tech Lab phase is an initial specification and implementation of technical interfaces, an improved integration of medical knowledge into the reasoning and validated component interactions of different vCare layers. Besides the clarification of technical requirements and the implementation of components, the exchange with the medical partners has also provided valuable input for the further development of the system, as can be seen from the individual test documentation.

Even though the implementation and difficult conditions took place, a remarkable added value in the validation from a medical point of view could be achieved through the regular exchange with the technical partners. The implementation of the Participatory Design, however, is a relevant step in the evaluation of the system and is a central component in view of the next major phase of the project.

After a successful Tech Lab phase, vCare now proceeds to the Living Lab phase. The deployment of the vCare system is currently being optimized, such that the Living Lab phase can start as planned and medical experts can explore the system.

While the tests performed in the TechLab phase focused on stand-alone activities and the processing of the corresponding information, the next phase of the project addresses the overall adaptation and implementation of a clinical pathway. In the TechLab phase, central components were validated and the exchange of information was defined. The Living Lab now focuses on collecting this information on a larger scale and processing it with the aim of adaptation to the particular patient’s needs and preferences. As the test procedure presented in this paper is not based on real patient data, the processing of real data will also play a central role ultimately preparing the pilot phase were the vCare solution will then be finally tests in the patients’ homes.

9. ANNEX

9.1 SCREENPLAY VIDEO VCARE: PARTICIPATORY DESIGN

NARRATIVE OF AN ORDINARY WEEK WITH YOUR VCARE COACH

INTRO

(with soundtrack)

A post production credits editing depicts:
1. EC logo on the left bounded with H2020 project claim and grant agreement number.
2. Transition to VCARE logo in the middle of the screen with the overlay claim.
3. Project logo fades out and consortium logos pop up.
4. Partnerships allocation within the European map (page 178 FIGURE 14).
5. Google Earth zooming into Italy and Milan area.
6. Cut and panoramic shot of Mrs. Maria's home building.

Script:

Doctor: *Good Morning Maria, here is your discharge letter with all the information you might need. Don't worry, we will continue to assist you also from home.*

PROLOGUE

(with soundtrack)

Milan, Monday, September 14th

8:15 A.M.
1. Maria is in the kitchen, having breakfast. The right-hand dexterity impairment doesn't let her correctly grip her cup of tea (Physical impairment n°1: right hand dexterity impairment).
2. Maria walks slowly in a hunched posture and, while limping, she holds her cane tightly on the left side (Physical impairment n°2: gait disturbances).
3. Maria is combing her hair in front of the sink and her facial expressions shows she has pain while raising her arm (Physical impairment n° 3: right shoulder pain).

SCENE 1

Maria makes her entrance in the living room activating the presence sensor located on the wall. She is warmly welcomed by her VC who begins to investigate Maria's sensations about the night. Maria sits on the sofa, watching the avatar on her tablet screen and, in a resentful tone, she begins to enumerate the physical impairments that affected her sleep. She complains especially about pain in her right shoulder and overall fatigue. She is afraid of her frequent nightly bathroom visits that could cause a sudden fall and worries about being unable to stand up again by herself. The VC listens to Maria patiently and, through a gentle and friendly verbal tone, here assures Maria offering his help to solve all her problems, by helping her to modify her daily lifestyle in a new and healthier one. The VC tells Maria that he is in touch with doctors, physiotherapists, psychologists who will provide constant support to overcome her problems.

In the end, the VC says goodbye to Maria inviting her to wear the activity tracker, so to remain constantly in touch with him and to ask for his assistance for any necessity.

Script:

Narrator: another day waits for Maria. The firsts morning movements have worsened her pain at the right shoulder that are tormenting her since her homecoming after the hospital rehabilitation.

VC: Good morning Maria! How was your night?

Maria: It was a very bad night. I slept too little. I got up many times to go to the bathroom, and this pain in my shoulder never leaves me. What shall I do, if I should fall?

VC: I'm really sorry Maria (with indulgent tone), but trust me! I will help you face these problems.
First of all, I will help you understand how you can improve your lifestyle. I will not leave you alone. I'm in touch with your doctor, your physiotherapist and your psychologist, who will guide me so that I can help you at any time!
Come on! A new day is about to start and week after week, you will observe your improvements and realize how many things we can do together! Remember to wear your special watch that will show you your improvements in physical activities that you will carry out from now on! Goodbye, that's all for now, I wish you a pleasant morning!

SCENE 2

11.00 A.M.

A notification from the tablet informs Maria about a new message from her VC; she moves close to the screen walking with her cane and she notices a blue blinking led. Scrolling the screen with her finger, she visualizes all the information related to her movement and risk levels, recorded by the monitoring system during the last week. In different sections, the VC displays daily number of steps, time of inactivity, mostly frequented rooms, hazardous situations, completed serious games sessions and goals already reached vs. still ahead.

Script:

Narrator: Maria is amazed about how much information her VC was able to gather with the maximum discretion: daily number of steps, time of physical inactivity, most frequented rooms and more... hazardous situations, physical and cognitive rehabilitation activities scores. Everything visualized on her tablet.

SCENE 3

15.30

Maria, while reading a newspaper on the couch, is informed by her VC that the physical rehabilitation lesson will begin shortly. The friendly voice diffused by the tablet invites her, whenever she is ready, to go in front of the TV. The VC reminds Maria to leave enough room between her and the TV screen, so as to have an appropriate and safe available space to do the activities.

Script

<u>VC</u> *(notification): Hi Maria! Remember that you have a physical activity scheduled soon in today's agenda. When you are ready, please go in front of the TV and clear the space around you to carry out the lesson in an appropriate and safe space.*

16.00

Maria goes in front of the TV screen switching on the REHABILITY application. At this point, the voice of the VC proposes her different motor games among the ones that her physiotherapist has foreseen specifically for her. Maria begins her physiotherapy session that will last 30 minutes.

The scheduled motor rehabilitation session on coordination and mobility of the upper limbs is ongoing. Maria is very focused on what appears on the screen and she almost forgets the pain in her right shoulder. She is in standing position at roughly 2 meters from her big television and she is moving with confidence in the surrounding space, perfectly synchronizing her movements with the game images proposed by the serious game. Audio and visual feedbacks constantly inform her about her scores and performance; sometimes the VC gives her motivational messages about her performances, alternating them with others about postural corrections.

Maria finished the last game and she massages her right shoulder; she takes her towel and she sits down on a chair near the TV. In the meantime, the VC, after showing the obtained scores, asks about the level of pain perceived by Maria and, once verified that this index is high (VAS 7), the VC reassures her that in the next session she will find a lighter motor game program, that will maintain her level of pain under control.

Script

<u>Narrator:</u> *The games for Maria's upper limb rehabilitation have been personalized by her physiotherapist.*

<u>VC</u> *(REHABILITY): (with motivating tone) very good, let's continue this way!*

<u>VC</u> *(REHABILITY): (with attentive and peremptory tone) pay attention! Keep down your right shoulder.*

<u>VC</u>*: Maria, I saw that your level of pain is too high, so for the next session I thought that you can carry out some lighter exercises, in order to keep your level of pain under control, without giving up on physical activity.*

Wednesday, September 16th

<u>SCENE 4</u>

10.15 A.M

Maria receives a notification from the VC about the activation, scheduled in her daily agenda, of a practical lesson available on the tablet about different types of hand grasps.

Maria, intrigued about the possibility to consult something strictly correlated to her dexterity problems and relieved by the fact that this lesson was prescribed directly by her reference doctor, accepts with pleasure to follow it, giving a hint of a smile. This activity will keep Maria busy for about 15 minutes.

At the end of the lesson Maria, cheered up by the information received, leaves the tablet over the coffee table and takes the phone to immediately call her daughter and share her enthusiasm about her achievements, made possible thanks to her precious and thoughtful VC.

Script

Narrator: *Maria's daily agenda updates with a new activity for her dexterity impairments. It is a practical session on different typologies of hand grasping (Voice in the video: "Now pick up the glass and bring it to your mouth…"). The lesson has been prescribed by her medical doctor. It consists in audio-visual instructions that engage Maria leaving her with a feeling of satisfaction and relief. Caught by an unexpected enthusiasm, Maria immediately picks up the phone to call her daughter.*

Maria: *It's going very well... even my leg...*

15.30

Maria is watching TV while sitting on the couch, when the VC sends her a notification on the tablet to remind her about the neuropsychology session scheduled at 16.00. The VC therefore suggests to Maria to keep the tablet close to her.

The REHABILITY application starts and the VC, after noticing a decrease in the cognitive fatigue level along the previous sessions, suggests to prolong the next cognitive exercises session, since Maria seems able to remain concentrated for a longer time lapse and her attention level is good. The VC therefore proposes her a range of attentive games, memory games, logic or calculation games. Maria selects the logic and calculation games from the tablet screen and the software enables the cognitive serious games package specifically prescribed for her by her neuropsychologist. The cognitive activity session begins and it will keep Maria busy for about 30 minutes.

Script

VC *(notification): Hi Maria! Remember that soon you have a scheduled session to stimulate cognitive functions; whenever you are ready, please take your tablet and start the session.*

VC: *Welcome in the cognitive stimulation session, I noticed in the last sessions that your cognitive fatigue is decreasing. So, today I was thinking to increase the duration of the session, since your attention and concentration are getting better. Very well Maria!*

Narrator: the VC then proposes to Maria to choose among cognitive games that stimulate the memory, attention, or the calculation abilities. The games have been specifically chosen for Maria by her neuropsychologist.

Thursday, September 17th

SCENE 6

10.45 A.M.

The VC, through the facial system recognition, voice tone analysis and verbal content, acknowledges that Maria is sad this morning. Moreover, since he recorded a low social interaction index in the last few days, the VC believes that Maria's mood needs support. Then, after checking on the weather forecast, the VC proposes to Maria a walk outside to reach the park, 450 m far away from her house, inviting her to wear appropriate footwear and to bring along her cane. Here she can find some benches where to sit in the open air and socialize with her friends, maybe talking to them about her fantastic Virtual Coach. In the end, the avatar underlines the importance of walking, to improve not only the weak physical resistance that Maria is experimenting in the last period, but also her mood and psychological wellbeing.

Script

VC: Good morning Maria. How was the night?

Maria: oh well, pretty good.

Narrator: thanks to the facial expression recognition, the VC acknowledges in Maria a deflection of the mood. The VC verifies the weather forecast and proposes to Maria a walk outside, inviting her to wear appropriate footwear and to bring along her walking cane. She will be heading to a park, where she can sit down on a bench and talk to her friends. Before saying goodbye to Maria, the avatar underlines the importance of walking to improve her psychological wellbeing also.

SCENE 7

12.13 P.M.

Maria has just come back from her reinvigorating walk in the open air, when her activity tracker starts vibrating. She looks at the clock screen and much to her surprise, she is complimented by her thoughtful VC for having surpassed the daily steps threshold for the first time since hospital discharge.

In the meantime, both Maria's daughter and her physiotherapist receive a notification about the goal she just reached. They can also check, in case they want to, the daily number of steps, the time of inactivity, most frequented rooms, hazardous situations, completed serious games sessions and all the goals set for Maria, at any place and time.

Script

VC (with enthusiastic tone): *Very well Maria!! You reached your daily number of steps goal! Your physiotherapist is proud of you.*

Narrator: *Both Mrs. Maria's daughter and her physiotherapist receive on their phone a notification of the reached goal.*

Friday, September 18th

SCENE 8

21.30

Maria has just finished her dinner and, while she is on the couch watching her favourite soap opera, the tablet recalls her attention with a notification. Maria notices that a red led light appeared on the screen but she has no intention to interrupt her favourite program now. After about 15 minutes, at the end of the episode, Maria stands up and consults the tablet. The VC informs her with a text message on the screen that he is worried since in the last 5 nights she went to the bathroom without using her cane, risking a falling trauma. With serious but sincere tone, the VC informs Maria that among tomorrow's activities she will find an informative lesson specifically about risks and hazardous situations at home, from which she can better realize how incautiousness may represent a threat to security and health.

Script

(Voice from the TV:

Man: they are all angled upwards from below, so whoever killed her must be shorter.

Woman: We cannot say this for sure.

Man: But we may suppose it.

Woman: alright, give me a copy of the video)

Narrator: *The VC informs Maria that he is worried for her, since he recorded that in the last 5 nights, she went to the bathroom without using her cane, risking to fall. Therefore, he informs her that tomorrow she will be offered an informative lesson on fall prevention.*

SCENE 9

22.00

Closing

Script

Narrator: *Maria is tired and she is very worried about being unable to sleep: the pain in her shoulder, the hindrance to the right hand, the fear about going to the bathroom during the night may affect her serenity and rest.*

Maria: *And again, I made it through the day! But will I be able to sleep well enough, tonight?*

Narrator: *while she is wondering about her worries, sleep unexpectedly falls on her and will restfully accompany her the whole night through, as it hadn't happened since a while. Maybe, then, Maria has found empathy and expertise in her VC and, finally, trusting him will give her back confidence and motivation to face her problems.*

9.2 User Experience Questionnaire (UEQ) for User Experience Evaluation

The English version of UEQ is presented below.

	1	2	3	4	5	6	7			Domain
annoying	○	○	○	○	○	○	○	enjoyable	1	Attractiveness
not understandable	○	○	○	○	○	○	○	understandable	2	Perspicuity
creative	○	○	○	○	○	○	○	dull	3	Novelty
easy to learn	○	○	○	○	○	○	○	difficult to learn	4	Perspicuity
valuable	○	○	○	○	○	○	○	inferior	5	Stimulation
boring	○	○	○	○	○	○	○	exciting	6	Stimulation
not interesting	○	○	○	○	○	○	○	interesting	7	Stimulation
unpredictable	○	○	○	○	○	○	○	predictable	8	Dependability
fast	○	○	○	○	○	○	○	slow	9	Efficiency
inventive	○	○	○	○	○	○	○	conventional	10	Novelty
obstructive	○	○	○	○	○	○	○	supportive	11	Dependability
good	○	○	○	○	○	○	○	bad	12	Attractiveness
complicated	○	○	○	○	○	○	○	easy	13	Perspicuity
unlikable	○	○	○	○	○	○	○	pleasing	14	Attractiveness
usual	○	○	○	○	○	○	○	leading edge	15	Novelty
unpleasant	○	○	○	○	○	○	○	pleasant	16	Attractiveness
secure	○	○	○	○	○	○	○	not secure	17	Dependability
motivating	○	○	○	○	○	○	○	demotivating	18	Stimulation
meets expectations	○	○	○	○	○	○	○	does not meet expectations	19	Dependability
inefficient	○	○	○	○	○	○	○	efficient	20	Efficiency
clear	○	○	○	○	○	○	○	confusing	21	Perspicuity
impractical	○	○	○	○	○	○	○	practical	22	Efficiency
organized	○	○	○	○	○	○	○	cluttered	23	Efficiency
attractive	○	○	○	○	○	○	○	unattractive	24	Attractiveness
friendly	○	○	○	○	○	○	○	unfriendly	25	Attractiveness
conservative	○	○	○	○	○	○	○	innovative	26	Novelty

Figure 107 - English version of User Experience Questionnaire

9.3 NON FUNCTIONAL REQUIREMENTS VS FUNCTIONAL REQUIREMENTS TESTS MATRIX

	R/RN	RN1	RN2	RN2	RN4	RN5	RN6	RN7	RN8	RN24	RN27	RN28	RN29	RN34	RN35	RN41	RN43	RN49	RN50	RN52	RN53	RN54	RN55	RN56	RN58	RN59	RN60	RN61	RN62	RN63	RN64	RN65
AIT	R3-1					12h																									*	
AIT	R3-8					12h																									*	
AIT	R3-9					12h																									*	
AIT	R3-10					12h																									*	
AIT	R3-11					12h																									*	
AIT	R5-1					12h																									*	
AIT	R5-3					12h																									*	
AIT	R5-4					12h																									*	
AIT	R5-5					12h																									*	
AIT	R5-7					12h																									*	
AIT	R3-4					12h																									*	
AIT	R3-5					12h																									*	
AIT	R3-6					12h																									*	
AIT	R3-7					12h																									*	
AIT	R5-6					12h																									*	
AIT	R3-2					12h																									*	
AIT	R3-12					12h																									*	
AIT	R3-13					12h																									*	
AIT	R5-2					12h																									*	
FZI	R4-1					12h																									**	
FZI	R4-2					12h																									**	
FZI	R4-5					12h																									**	
FZI	R4-7					12h																									**	
FZI	R4-7-1					12h																									**	
FZI	R4-7-2					12h																									**	
FZI	R4-7-3					12h																									**	
FZI	R4-7-4					12h																									**	
FZI	R4-7-5					12h																									**	
FZI	R4-8					12h																									**	
FZI	R4-3					12h																									**	
FZI	R4-4-1					12h																									**	
FZI	R4-9					12h																									**	
FZI	R6-1-2					12h																									**	
FZI	R7-6					12h																									**	
FZI	R4-6					12h																									**	
IMA	R5-9					12h																									***	
IMA	R5-8					12h																									***	
IMA	R5-8					12h																									***	
MYS	R2-1					12h																									****	
MYS	R2-2					12h																									****	
MYS	R2-7					12h																									****	
MYS	R7-5					12h																									****	
MYS	R2-3					12h																									****	
MYS	R2-8					12h																									****	
MYS	R2-9					12h																									****	
MYS	R2-10					12h																									****	
MYS	R7-7					12h																									****	
SIV	R7-1					12h																										
SIV	R7-2					12h																										
SIV	R7-3					12h																										
SIV	R7-4					12h																										
TUD	R6-2					12h																									*****	
TUD	R6-2-1					12h																									*****	
TUD	R6-1					12h																									*****	
TUD	R6-1-1					12h																									*****	

*AIT hardware configuration	200GB HDD SSD, 16GB RAM, 3 cores CPU
**FZI hardware configuration	256GB HDD SSD, 16GB RAM, 5 cores CPU
***IMA hardware configuration	1TB HDD SSD, 64GB RAM, 5 cores CPU
****MYS hardware configuration	200GB HDD SSD, 16GB RAM, 3 cores CPU
*****TUD hardware configuration	200GB HDD SSD, 16GB RAM, 4 cores CPU